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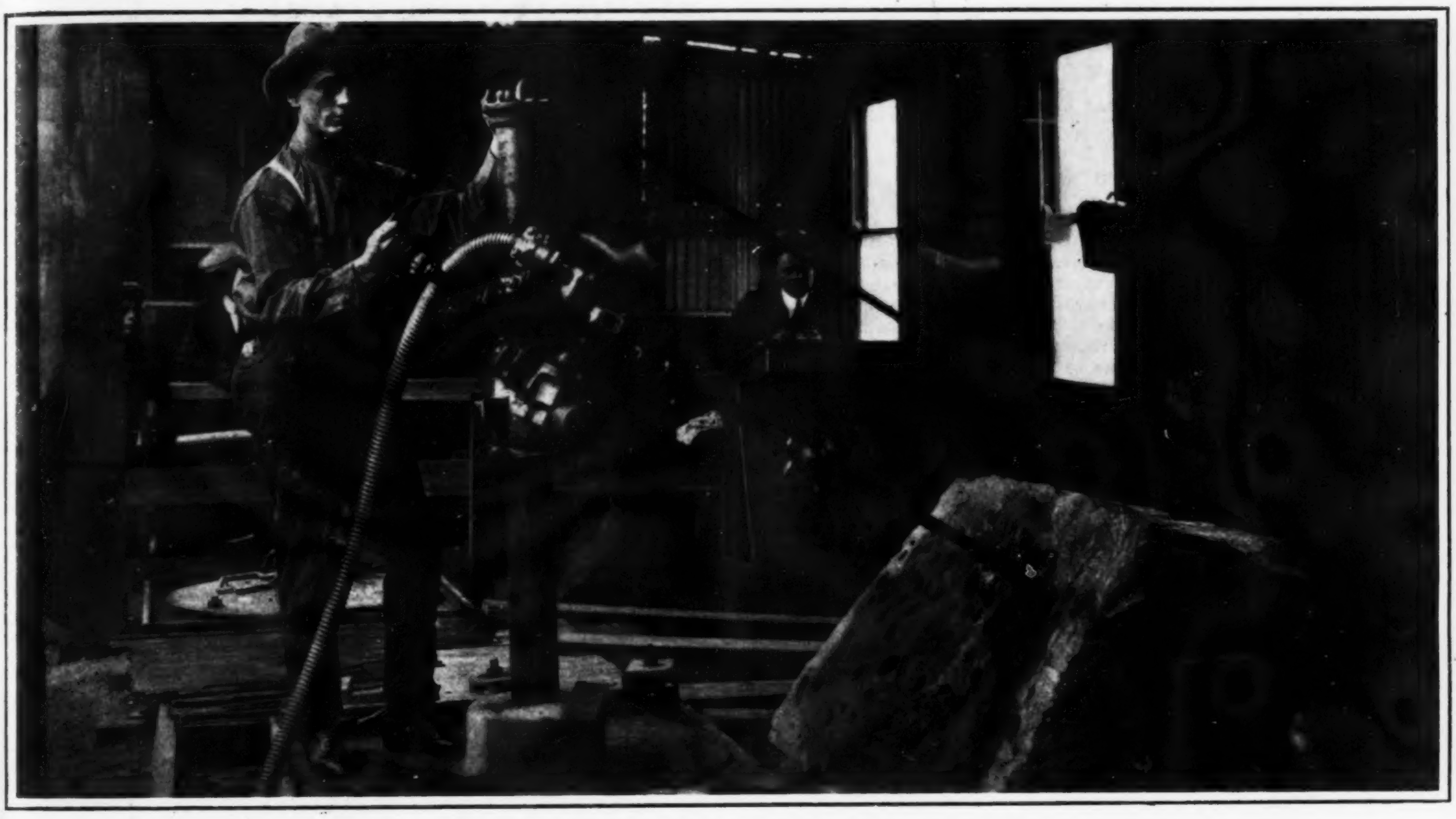


THE HOLMAN DRILL AT WORK IN THE GREAT PRIZE CONTEST. THE MACHINE IS MEANT FOR DRIVING HOLES IN SMALL QUARTERS.

THE SISKOL DRILL IN TESTING OPERATION OF MACHINES FOR USE IN NARROW STOPES OR MINE TUNNELS.

THE STOPE-DRILL COMPETITION IN SOUTH AFRICA.

THE STOPE DRILL COMPETITION.

BY GEORGE WATSON

In the beginning of 1908, the Chamber of Mines, in co-operation with the Transvaal Government, arranged for a practical trial of small rock drills for stoping work under the working conditions obtaining on the Witwatersrand. Two prizes of £4,000 and £1,000 respectively were offered for competition, the basis of award being economy in working. A committee of professional men was appointed by the Government and the Chamber to draw up the conditions governing the competition, and these conditions were published in the technical and other journals in all countries from which it was considered entries might be received. Twenty-three entries were received—12 from Great Britain, 2 from the United States, 4 from Germany and 5 from local makers.

The competition commenced on February 15th, 1909, and lasted much longer than was anticipated, mainly owing to the difficulty in obtaining the minimum air pressure specified in the rules governing the contract.

Of the twenty-three machines entered ten survived the elimination trials and entered upon the competition proper, but of these five, for various reasons, fell out. The remaining five were the Chersen, Holman 2¼ in., Holman 2¾ in., New Century and Siskol.

We understand that it has been decided to divide the prizes equally between the Holman 2¼x5 in. and the Siskol 2¾x6 in. The Chersen drill is credited with third place in the contest.

As indicated in Supplement No. 1799, the essential difference between the leading machines illustrated herewith, is that the Siskol is the faster running drill, while the operating costs are considerably less in the case of the Holman.

SUPERHEATING AT SEA.

IS IT ADVISABLE?

The Engineer is of opinion that something may very well be said about superheating at sea as a corollary to what Mr. Hughes has told us about superheating in locomotives. The first point worth notice is that comparatively few English ships are fitted with superheaters. We learn from a paper read by Mr. White last November before the Institute of Marine Engineers that there are now in April afloat about 350 vessels so fitted, some of small size. Of these, Germany takes the first place in numbers, having fitted out about 274 vessels, 188 of which are for canals, lakes, rivers, and coasting service, 81 sea-going steamers, and five vessels for the Imperial navy. Britain has about 40 vessels using superheated steam, including four cruisers of his Majesty's navy. America can be credited with 20, of which eight are naval vessels; and France about 10, merchant ships. The number has been since increased; there are now 262 Schmidt superheaters afloat. Curiously enough, the Schmidt system seems to be used almost to the exclusion of other devices, to such an extent that it might be said that there would be no superheating at sea if the Schmidt system had not been invented. There are, of course, many other inventions in the market; none of these seem to have been so carefully pushed. The value of superheating can only be tested on the lines laid down by Mr. Hughes—saving in coal, so much; increased first cost, maintenance, depreciation, etc., so much. The general public are supplied with ample information on the first point, with little or none on the second. We are told that the cost of maintenance is very small. So it ought to be with new superheaters and new engines. What it may be remains to be seen; but the outlook is favorable. So far, however, conviction does not seem to have reached the British shipowner.

Superheating at sea, like superheating on railways, may be treated from the theoretical or the practical point of view. There is nothing to be urged against the first, save a certain amount of uncertainty. The difficulties of the marine engineer lie partly in reconciling theory with practice, and partly in dealing with new working conditions of which theory knows nothing, and consequently takes no account at all. For instance, gunmetal must be avoided. Copper steam pipes cannot be used, because they become weak and brittle at high temperatures. Steel must be substituted. Now, copper is very expensive, and copper pipes would not be used save for overwhelming reasons of expediency. To abandon them in favor of steel obviously introduces some element of risk, which copper was, rightly or wrongly, intended to keep out. Gunmetal stop valves again are no doubt better than those of steel; but with superheated steam they have to go. All this is a matter of practical importance to the shipowner; but it has nothing whatever to do with theory. Again, it seems to be admitted without dispute that much oil must be put into the engines. But for years past the efforts of marine engineers have been devoted to keeping oil out of them, and with very great success. Oil is very bad indeed for boilers. In locomotives the steam does not return to the boilers; in marine machinery it does. Elaborate filtering arrangements are indispensable; but it is by no means easy to find room for big filters in an engine-room. The theory of superheating takes no interest in filters. We might extend our detailed list of practical difficulties were it necessary; we do not think it is. Engine-room management is altered and made more troublesome. Radical changes in constructive details are introduced; new risks have to be encountered. What does the shipowner secure in return? The answer is, a reduction in the quantity of coal required to carry a ton a sea mile at the speed he finds most suitable. And so we come to the kernel: How much fuel is saved by superheating?

Here we are, metaphorically, indeed at sea. At one end of the scale we hear of a reduction of as much as 30 per cent, at the other end 10 per cent. The saving is held to be due to two causes—first, the suppression of "the missing quantity," the cylinders being kept too hot to condense the steam. Secondly, the augmentation in the volume of steam. The amount of this is very easily ascertained. The formula is $V : V^1 :: t + 461 : t^1 + 461$. In words, multiply the given volume by the new absolute temperature and divide by the original absolute temperature. Let the pressure be 215 pounds absolute, the temperature will be, omitting fractions, $388 + 461 = 849$ deg. F. Let the superheat be 212 deg., then the temperature will be $600 + 461 = 1061$. Thus 100 cubic feet of dry superheated steam will become 125 cubic feet. Ostensibly this is equivalent to making three boilers do the work of four. It seems strange, however, that no one who has to do with superheated steam appears to attach any importance whatever to the increase in volume; and, furthermore, we are assured that in a triple-expansion engine the superheat never reaches the intermediate cylinder. This is the more remarkable for we are assured that the first cylinder walls are kept so hot that no liquefaction takes place. But it is the re-evaporation of liquefied steam during the exhaust that is held to be accountable for the missing quantity; and there does not seem to be any valid reason for the disappearance of the superheat, unless, indeed, we are to assume that it is all converted into work. In point of fact, superheat does reach the intermediate valve chest, whether it gets into the cylinder or not. It is noteworthy that a combined diagram from an engine working with superheated steam is seldom, if ever, made public. No doubt there are multitudes of them. It is not easy to tell the difference between those we have seen and saturated diagrams from the same engine.

After all has been said and due weight given to each and every argument, sufficient evidence remains to convince the most incredulous that a noteworthy reduction in coal bills can be secured by the use of superheated steam at sea. That has always been the case. It was the case fifty years ago. We cannot call to mind a single instance in which it has had an adequate trial on a sufficient scale without being followed by a reduction in the quantity of coal burned. To-day take, for example, the steamship "Schwann," a Bremen boat running between that port and London. We understand that she has very good triple-expansion engines, working with much economy. She was fitted with a superheater. Her owners report a saving for 150 days steaming of from 400 to 415 tons, which at 16s. a ton would amount to over £300 ($1,500) a year. The first cost of the superheater installation was, we are told, £250 ($1,250), which seems ridiculously small. In our issue of last week will be found detail information concerning the "Schwann," from which our readers can draw their own conclusions. Then we have "La Garonne," an Atlantic liner of small dimensions, indicating 1,320 horse-power. She has 850 square feet of superheating surface, and 2,766 square feet of heating surface. The temperature of the boiler is 632 deg. The chief engineer reports a saving of 16 per cent in coal. The "Lowenburg," of the Hansa line, a ship of 4,444 tons, 1,740 horse-power, gives a similar saving. It is worthy of careful notice that in both cases the boilers are worked under forced draught on Howden's system, which appears to confirm the statement that forced draught must be used with the Schmidt superheater. If it can be shown that the cost of a superheater can be repaid in a year, it is needless to raise questions of maintenance, seeing that it will probably last several years. The principal element of uncertainty is the obvious lack of faith manifested by superintending engineers, steam engine builders, and shipowners. It does not do in the present day to attribute reluctance to adopt a new thing to prejudice. There is always something behind when the so-called "prejudice" regulates the policy of numbers of shrewd competitive men. But the use of superheaters at sea, at any rate in German ships, is extending; and doubts will be set at rest as soon as superheaters have been so long at work that the question of the cost of maintenance will be finally settled. At present, unfortunately, it is difficult to get impartial, and at the same time extensive, information on this point. Obviously, it can only be supplied by shipowners' books; which is tantamount to saying that it cannot be had at all.

BOILER INCRUSTATIONS.

The effect of incrustations in retarding heat has been greatly over-estimated, according to E. Reutlinger. On the other hand they may cause dangerous overheating of the plates. Calculation shows that an an incrustation 5.5 millimeters (¼ inch) thick may cause losses of heat amounting to 20 to 30 per cent according to the temperature of the firing gases. Oil or fat is much more objectionable in this respect; a coating of tar 0.3 millimeters thick caused a loss of 30 to 45 per cent. If the transference of heat is effected entirely by contact and not by radiation, the losses caused by incrustations may not, where hot gases form the heating medium, be more than one-third of the above amounts; but they are much greater where the heating is done by hot water or saturated steam—in cases as much as 70 to 80 per cent. In such cases (steam-heated evaporators, brewing coppers, etc.) incrustations should be most carefully avoided. Where the temperatures of the heating medium and of the material heated do not remain constant, the author comes to the following conclusions: 1. *Heating medium constant, heated fluid variable.*—(Steam-heated hot-water apparatus, surface condensers, etc.) For apparatus not too heavily worked and of moderately large size, the loss may amount to 15 to 30 per cent; for smaller heating surface, or rapid circulation, as much as 50 per cent. 2. *Heating medium variable, heated fluid constant.*—(Boilers, and all arrangements in which steam experiences changes of pressure and temperature at different parts of the heating surface). The loss may amount to about 7 per cent if contact-heating alone be considered; 5 per cent, if the heating be both by contact and radiation. The loss increases somewhat with the demands made upon the boiler; but even in a locomotive boiler in full work, an incrustation of 2 to 3 millimeters thick will not cause a loss of more than 5 to 9 per cent. 3. *Both heating medium and heated fluid variable.*—(Feed heaters, economizers, spray condenser.) For installations heated by saturated steam, losses of 20 to 35 per cent; for those heated by gases or superheated steam, losses of 5 to 15 per cent. For very narrow tubes, or for heat-transference between moving liquids, the loss may amount to 50 per cent.

Evans's Metallic Cement.—Alloy 1 part cadmium and 2 parts tin by melting together, reduce to chips and treat with an excess of mercury. The surplus mercury is removed by squeezing in a leather bag. Soften by kneading.

OUR INEFFICIENT INDUSTRIAL ORGANIZATION.

STAFF AND LINE IN THE WORKSHOP.

BY HARRINGTON EMERSON.

In American organization a successful man becomes president, he selects his staff, his cabinet and—he puts it up to them. Each in turn selects his staff of managers and—puts it up to them. The manager selects his superintendents, and passes the power and responsibility on to them. The superintendent selects foremen, and delegates to them the power "to make good." The foremen select their workmen, and transmit to them the power to do the thing the president really wanted done.

The man at the bottom, with the least spare time to plan, the least training, the least compensation, runs the whole affair. This is the type—so usual, so universal, that many will wonder that it is questioned. It is the baboon, the wolf-pack, type of organization and it is all wrong.

Contrast this with the type of organization von Moltke imposed on a Prussian army. He left apparently intact the predatory form; but he created *staff*, and though it was an elementary and inadequate staff it made his stupendous achievements possible. Von Moltke realized that there were natural laws superior to any general orders of his, that the general orders would be effective in exact degree as they utilized natural laws to the best advantage. He therefore created a general staff of specialists, officers, students, experts, acquainted with and skilled in the knowledge of general laws, and it was with their knowledge that he outfitted his armies, planned his campaigns, and executed his designs. The plans of his general staff prevented the issuance of orders contrary to the laws of nature; it stimulated the issuance of orders in accordance with the laws of nature; just as effectually as wheel flanges keep locomotives on the track and as steel rails lessen wheel friction, so there was elimination of futile waste, the promotion of efficiency. It required no revolution, no tearing down of what was to change offense and destructiveness into defense and constructions. Bismarck's main aim was not to conquer Austria or France, but to build up Prussia and Germany, and an army with a new organization was the instrument.

The stone, spear or sword was distinctly an adjunct to primitive man, but just as distinctly modern man is an adjunct to t.e machine tool, to the locomotive, to the twelve-inch gun. We would use them automatically if we could, and dispense with the man, even as we now drill oil and gas wells two-thousand feet deep and dispense with a well digger. Having reversed the relation of worker to his tools, we must of necessity reverse the relation of officer to private, of official to employee; we must reverse the administrative cycle. The employee no longer exists merely to aggrandize and extend the personality of the employer, but the latter exists solely to make effective the totally different function of the employee.

Modern industry as distinguished from primitive industry is run with equipment. It is the locomotive that pulls the train, the car that carries the freight. They are there for this purpose, and this is the inspiration of their design, construction, operation and maintenance.

We would willingly dispense with the locomotive engineer and fireman if we could; they are capable of something better than watching signals and shoveling coal. The only excuse for putting human beings on such work is that the equipment used still requires human supervision. Similarly, in the shop, the equipment and its purpose are the main considerations and the duty of the machinist is primarily to his equipment. As we rise in the line we find each higher grade legitimately existing solely for the benefit of what is below, not for the amusement of what is above. The foreman is there not to relieve the superintendent of responsibility, but to direct the men on the machines operating to repair the locomotives pulling the freight. The general manager is there for the sake of the superintendents, the vice-presidents are there for the sake of the managers, and the president is there for the sake of the vice-presidents.

Ideals may have been imposed or have been conceived by the president—the plan, perhaps, to develop a continent. The instrument used is a corporation, whose efficiency reward is dividends earned by carrying freight and passengers. These ideas of development, of earning capacity, remain; but to carry them out natural laws must be observed, these laws being efficiently taught by those qualified by study and experience to teach and direct. The laws are applied by officials each of whom is servant to the men over whom he has directing control. In vain does president or vice-president, manager, or superintendent issue orders and delegate power under current organization. Knowledge and ability, desire and interest, become diluted with every spreading step.

It is within my knowledge that the able, conscientious, and indefatigable chief engineer of the greatest constructive enterprise the world has ever undertaken was advised that the efficiency was very low, not aggregating much over 50 per cent, and of the remedies. He was offered, free of charge, efficiency staff advice. He did not avail himself of this offer because he belonged to the old school, because he did not know that standards could be established, much less realized, although in sanitation he accepted fundamental organization and authority; and so the actual results under him are costing $200,000,000 more than they should have cost if he had been von Moltke, if he had had von Moltke's conception of modern organization.

With millions of flowing details, each separately elusive as one among millions of buzzing insects, the task seems hopeless and staggers us by its immensity, until we remember that honey bees, the most independent of union workers, have, as a union, gratefully accepted efficiency administration; that deleterious mosquitoes have been suppressed at the Isthmus of Panama by preventing their birth; that the task of modern organization is to control millions of details through a staff of specialists who supplement each working unit from tool, machine, implement, up to president and to corporation.

The central part in railroading is the locomotive. The one essential for a locomotive is to stay on the track. This is an absolutely modern conception. There was no such idea in the centuries of the pyramids, nor even in the days of Napoleon and of Robert Fulton. Because it is modern, an organization has been created to see that it worked. One might evolve the operation of a modern railroad from the wheel flange. The presidents and their staffs dictate a few letters each day, perhaps a hundred thousand in all; but that rails may stay in place and resist the side pressure of the wheel flange, two thousand five hundred million spikes are inspected every day by the humble track walker, and though the train runs under the supreme control of conductor, of engineer, of fireman (as much as the dray runs under the control of its driver) the difference lies in the fact that all the departments of track maintenance, of equipment maintenance, and half the operating department, exist solely for the purpose of moving the wheels on top of the rails, of transmitting safely 2,600 horse-power through six half-inch squares of frictional contact.

This is a stupendous result empirically achieved, since as yet but little has been standardized as to either truck, motive power, equipment, or operation, and no cost efficiency standards have ever been theoretically established as possible ideals.

The defective wolf-pack type of organization is one in which a chief issues arbitrary orders to his subordinates expecting them somehow or other to execute them. The perfected organization for industrial upbuilding and efficiency is one in which specialists formulate the underlying principles, instruct as to their application, and relentlessly reveal both their observance and neglect.

It is of minor importance how the knowledge and experience of specialists is made available for the control and guidance of all line officials. Independent accounting firms impose their checks on even the greatest corporations. Independent efficiency specialists might well impose more profitable and important checks on the greatest corporations. The same end might be attained of an efficiency engineer, advised by an efficiency board, holding a position of efficiency authority on a president's staff, even as comptrollers hold positions of authority as to accounting.

Accounting, however accurate and minute, cannot of itself bring about efficiency. It tries to evolve a standard by comparison, showing that on some other occasion the record was better, therefore presumably always possible.

No modern business presumes to run without some kind of accounting. This is embryonic recognition of the need of staff regulation. Accounting in all its phases is a minor division of one of the twelve efficiency principles, *trustworthy, immediate and adequate records*. The eleven other principles are none of them less important than records, some of them more important.

A modern undertaking of any kind will be prepared to operate efficiently when it reverses the cycle, when each minute operation can attract to itself all the required knowledge and skill in the universe. It is only through a qualified staff, applying as needed to every detail the twelve principles of efficiency, that the cycle can be practically reversed.

How, practically, should this staff be formed and made effectively operative? No patent medicine exists that is a universal tonic for all forms of debility. No two organizations are alike, either in their merits or in efficiencies, and the object of staff is to provide what is missing, whether in organization, recognition of efficiency principles, or their application.

It is evident that there ought to be a controlling efficiency engineer, even as there is a comptrolling accountant or auditor. The comptroller as to accounts acts as a funnel into which are drawn all the best experience of the world as to accounting, and after filtration it is carried authoritatively down the line and applied where needed. A competent librarian acts as an intermediary between all the knowledge of the universe collected in books, and the great miscellaneous reading public seeking information. An efficiency engineer ought similarly to act as a funnel, being equipped to gather from all available sources whatever is of operating value for the organization he is advising.

Just as it is the business of the comptroller to apply accounting principles, so it is the business of the efficiency engineer to apply to all operations the principles of efficiency. The duty of the executive desiring efficiency, who has accepted the defensive, upbuilding type of organization by appointing an efficiency chief, is not to demand details, but to demand a certain efficiency—whether 80, 90, 100 or 110 per cent—and he should make himself sufficiency familiar with the twelve efficiency principles to apprehend their bearing on ultimate efficiency, thus qualifying himself to second and make operative the plans of his expert. If he waives the attainment of any definite excellence, he may set up his own limiting standards as to each of the twelve principles and instruct his efficiency engineer to accomplish what he can under the limitations imposed. Everybody knows that a horse trotting a mile in two minutes can be secured, and that the mile will be trotted in this limit if every condition required for success is provided. On the other hand, a wagon may be loaded with 5,000 pounds, a mile measured over a bad road, and the horse and driver told to do the best they can. They may do well, but it will not be a two-minute performance. In operation, a whole plant—a whole railroad, for instance—can be brought up to the highest practicable efficiency if the principles are applied through a suitable organization. A defective organization and emasculated principles will attain correspondingly lower results, usually equally unsatisfactory to the executive and to his staff assistant.—Abstracted from a paper in the Engineering Magazine.

NEW RUBBER COMPOUND.

In an English patent recently granted to J. Smith, of Chicago, it is claimed that the addition of a finely powdered friable bitumen, such as grahamite, to a rubber mixing, renders such mixing better able to resist the action of the atmosphere, sunlight, acids, alkalis and oils. The bitumen is preferably powdered so as to pass a 200-mesh sieve. An example of a mixing for a soft rubber prepared with the addition of this ingredient, is as follows: Rubber, 15 pounds; reclaimed rubber, 15 pounds; sulphur, 1½ pounds; and grahamite, 17½ pounds, vulcanized, in the form of 1-inch thick pieces, in molds, at a steam pressure of 60 pounds for 35 minutes. To produce a hard rubber 2 pounds of litharge may be added to the above mixing, the amount of sulphur increased and the vulcanization carried out as follows: The steam pressure begins at 60 pounds and is gradually increased, during 30 minutes, to 75 pounds, at which it is maintained for two hours. The product is cooed for one hour before being taken from the mold.

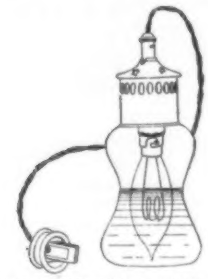
Cement for Leaky Casks.—Thoroughly mix 42 parts of tallow, 34 parts of wax and 67 parts of hog's lard, and while stirring heat it. Then take it from the fire, and while it is cooling stir in 42 parts of finely sifted wood ashes. After the sweating joint in the cask has been dried, apply the softened mixture smoothly to the leaky place. The mixture will remain good for a long time in a dry place and is always immediately available.

NOVELTIES IN INVENTION.*

SOME FRENCH CURIOSITIES.

AN ELECTRIC PERFUME VOLATILIZER.

In a perfume volatilizer which is sold in Paris, the perfume, preferably in the form of an alcoholic extract, is contained in a glass or porcelain vase, having a high cylindrical cover of sheet copper. This cover is perforated with a ring of orifices for the escape of the perfumed vapor, and through its top passes a tube, which carries at its lower end a small electric incandescent lamp and encloses its wires.

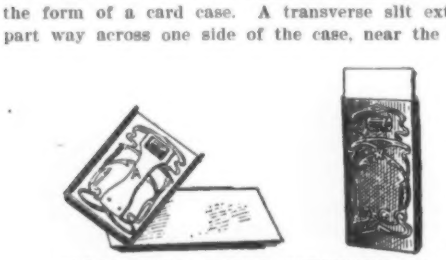


ELECTRIC PERFUME VOLATILIZER.

The tube bears a number of pegs at different levels, by means of which the lamp can be immersed to various depths in the liquid. The wires may be connected with any circuit of 110 to 130 volts. The liquid is heated to from 100 to 170 deg. F. The apparatus also furnishes a convenient and effective means of volatilizing formaline, infusion of eucalyptus and other antiseptic liquids.

CIGARETTE PAPER DISTRIBUTOR.

It is often difficult to separate, even by blowing or moistening the finger, a single sheet from a pack of cigarette papers. A sheet can be separated readily with a bit of India rubber, but this is not always at hand. The "Quick" is a French cigarette paper case, which has been devised to meet this difficulty. It has the form of a card case. A transverse slit extends part way across one side of the case, near the open end, and a small fluted rubber roller is mounted just outside this slit and parallel to it. By turning this roller with the finger, a single sheet of paper is drawn from the pack contained in the case.



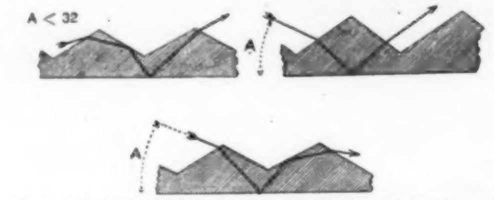
CIGARETTE PAPER DISTRIBUTOR.

PARASOL GLASS.

In the last few years several ingenious methods have been devised for the illumination of dark rooms by the employment of windows made of glass cut into prismatic and lenticular forms, for the purpose of deflecting in the desired direction a large proportion of the incident sunlight which would otherwise be diffused and practically wasted. A new form of window glass has now been invented, for the purpose of producing the opposite result.

Parasol glass freely admits diffused daylight, but, as its name indicates, it possesses the curious property of excluding the direct rays of the sun, by means of refraction and total reflection.

It was invented by M. Sée, a specialist in factory construction, and is designed especially for use in factories which are lighted from the roof. This method of construction is common in spinning and weaving mills, and in all factories in which the great weight of the machinery prohibits loft construction, while the area occupied is too extensive to be lighted from the sides. But a one-story building, lighted from the roof, would be as uninhabitable as a greenhouse, on hot summer days, if the direct rays of the sun were allowed to enter. This difficulty can be partially overcome by the employment of muslin window shades, ground glass, or glass covered with a blue pigment that arrests the heat-producing rays without greatly diminishing the light.

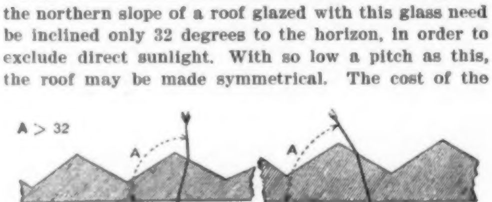


TOTAL REFLECTION OF DIRECT SUNLIGHT BY PARASOL GLASS.

A still better result is obtained by dividing the roof into a number of narrow sheds, with their ridge poles running east and west, and their northern slopes, in which all the windows are placed, inclined at an angle of 60 degrees to the horizon, while the southern sides are much less steep.

As the maximum altitude of the sun (in France) is about 60 degrees, little direct sunlight can enter these roof windows at noon, even at or near the summer solstice, and none can enter at any other season, at noon; but the sun's rays enter obliquely in the morning and afternoon, in summer, and still more direct sunlight is admitted if the location of the site, or other considerations, make it impracticable to build the sheds with their ridges directed exactly east and west.

All of these inconveniences can be avoided by using parasol glass, which is made with one face plain and the other in the form of a series of triangular prisms, the faces of which are inclined 32.7 degrees to the plane face of the glass. Every ray of light which falls on the prismatic face in a direction inclined 32 degrees or less to the plane face, suffers total internal reflection at the plane face, with or without refraction at the prismatic face. Hence, at the latitude of Paris, where the maximum altitude for the sun is 64 degrees, the northern slope of a roof glazed with this glass need be inclined only 32 degrees to the horizon, in order to exclude direct sunlight. With so low a pitch as this, the roof may be made symmetrical. The cost of the parasol glass will be more than covered by the saving in cost of construction thus effected. If the roof cannot face directly north, its slope must be increased to 35, 40, 46 or 53 degrees for a deviation of 10, 20, 30 or 40 degrees, respectively. With the higher pitches, the series of unsymmetrical sheds must be employed, but the use of parasol glass will not be found advantageous even in these cases.

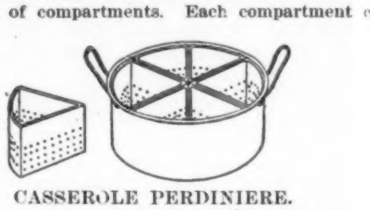


TRANSMISSION OF DIFFUSED LIGHT BY PARASOL GLASS.

The efficiency of parasol glass in diminishing the amount of radiant heat admitted was strikngly demonstrated by an experiment in which boxes, containing thermometers and covered with various forms of glass, were exposed to the sun. The thermometer covered with cathedral glass rose 27 deg. F., while the thermometer covered with parasol glass only 5.4 deg. F.

CASSEROLE PERDINIERE.

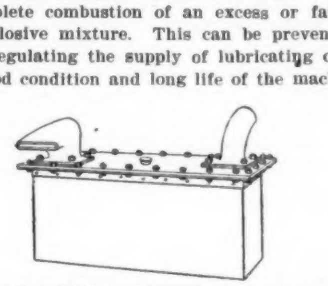
The name "casserole perdiniere" has been given to a new French culinary utensil, in which several kinds of vegetables can be boiled simultaneously, in separate waters. As the illustration shows, the device is simply a pot divided by radial partitions into a number of compartments. Each compartment contains a perforated inner vessel of similar form, in which the vegetables are placed, and by means of which they can be removed at the proper moment without disturbing the contents of the other compartments.



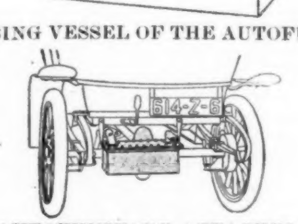
CASSEROLE PERDINIERE.

THE AUTOFUMIVORE, A SMOKE-CONSUMING DEVICE FOR AUTOMOBILES.

The emission of smoke by an automobile is due to the incomplete combustion of an excess or fatty oil in the explosive mixture. This can be prevented by carefully regulating the supply of lubricating oil, but for the good condition and long life of the machine it is always preferable to use too much oil than not to use enough. Two French inventors, Guttin and Ningter, have devised an attachment called "autofumivore," which automatically rids the exhaust gases of smoke, and thus relieves the chauffeur from the fear of violating a law which is not easy to obey.



ABSORBING VESSEL OF THE AUTOFUMIVORE.



THE AUTOFUMIVORE ATTACHED TO AN AUTOMOBILE.

The autofumivore consists essentially of a small vessel, which is attached to the exhaust inlet in such a manner that the gases are compelled to pass through it before escaping into the atmosphere. The vessel is divided into a number of compartments by perforated plates, for the purpose of securing intimate contact of the gases with an absorbent substance, of secret composition, which is said to arrest all solid particles.

* From La Nature.

THE SILENT CHAMBER AT UTRECHT.

In the City of Utrecht is a silent chamber or "camera silenta," which has been in use since 1904. To prevent disappointment such a chamber should fulfil three conditions: (1) The inner surface of the walls should be covered with a material which does not reverberate. (2) The isolation must be effected by a double wall, with interstices of air of such a trifling thickness that resonance of audible tones is quite out of the question and no connection is left between the two walls other than a few narrow lead contacts. (3) The isolation of the outer wall of the building and of its bottom has to be as complete as possible; the first isolation should take place through a properly constructed secondary apartment. If a choice has to be made of a position underground or on a higher floor for such a sound-proof chamber, the higher floor is to be preferred for the conduction of sound in by the bottom is the defect most difficult to overcome, and this difficulty is reduced in the higher floor as compared with a basement. Among the ten researches carried on by Zwaardemaker in this chamber during the last six years, the following may be specially noticed: (1) Unless a perforation of the tympanum exists, the "sensation of stillness" may be observed as a kind of buzzing, in which, on a closer analysis, a soft rustling as of the wind in the tops of trees may be distinguished, accompanied by a high-pitched whistling ($\pm g^{o}$). Persons in whom this physiological ear-buzzing is indistinct perceive a feeling of oppression. (2) The spreading of the sound round a tuning-fork with the situation of the well-known interference-planes may be accurately traced, without making the mistakes that must necessarily arise in apartments with echoing walls. (3) The action of the winding mollusk-shells as to their resonance for buzzes may be proved directly. (4) The sound-extinguishing action of different means of isolation may be traced with perfect security. For reports by dropping steel balls on a steel plate and for tones by electrically touching purely tuned bells, in both cases the instrument is put in a small non-resonant space whose walls are covered with the material to be examined. The completest isolation for a given thickness of walls is got for *trichopièse*, then follows the peat-moss plate from Klazienaveen, then the corkstone.

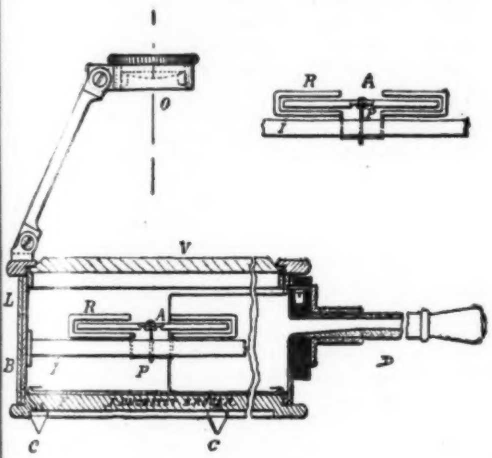
The packing of condenser tubes is a somewhat tedious process, whether it be accomplished with wooden ferrules or by the more common process of plaited cotton wound into the recess in the tube plate by means of a special tool. According to the Marine Engineer and Naval Architect some rows of condenser tubes packed experimentally with rings of fiber appear to have given satisfactory results with a considerable saving in time. These rings are made to suit the depth of the recess in the condenser tube—about half-inch—and to slip easily over the tube.

THE RADIOSCOPE.

MEASURING RADIO-ACTIVITY

BY OUR PARIS CORRESPONDENT.

The instrument in the following description and known as "radioscope" has been devised by M. Szilard, who is connected with Mme. Curie's laboratory at the University of Paris. It is a portable apparatus of great sensitiveness for use in making measures of radio-activity of various substances; it unites the three qualities of sensitiveness, precision and portability; is easy to use in practical work, and is no doubt the best which has yet been devised. Portability is now an important point, for such measurements often need to be made outside the laboratory, as for instance, observation of minerals, the soil, residues of thermal springs, and the atmosphere. The principle of the apparatus is the usual one, that is, we use a system which is first given an electric charge, and it is then brought near a standard radio-active substance, so as to cause a discharge, then the operation is repeated until the sample substance and we compare the two rates of discharge.



Figs. 1 and 2.

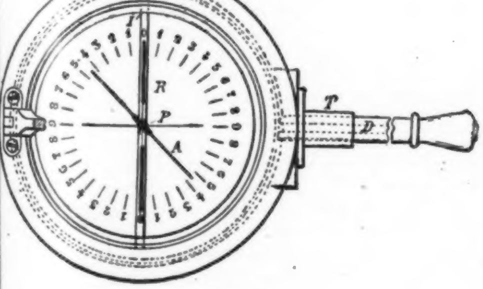


Fig. 3.

But the principle of the indicator of the charged systems differ essentially from what has yet been devised, and the indicator consists of a rigid needle turning around a fixed scale, as shown in Fig. 3. A metal box, Figs. 1 and 2, which is also seen at the upper part of the photograph, has fixed to one side an insulating support I containing a very fine point P so as to receive a light magnetized needle A. Around the needle is a fine metal strip R which is electrically joined to it, so that the whole system is well insulated from the box. At the top is a glass plate V with a circular scale. To avoid errors of parallax, we read by means of a lens O at the top, and the glass plate carries a set of fine lines on each face which must be superposed when the eye is in the axis.

The standard is a disk covered with black oxide of uranium so that the radiation per square centimeter corresponds to that of a centigramme of oxide. As the surface is 50 square centimeters it suffices to weigh 50 grammes of the matter to be tested and to spread it evenly upon another disk of the same surface so as to have the activity expressed directly in units of uranium oxide. We introduce the standard disk first through an opening in the side of the box so as to bring it under the needle. This latter has been previously charged and has a given deflection, but it becomes discharged by the action of the disk and falls toward zero. The measurement is made as follows, by first giving a charge to the needle, and this is done by means of the rod D which penetrates into the box through the guide tube T (Fig. 3). This rod comes against the needle so as to stop it in place and serves also to charge the needle from the outside. The charge is given by touching the rod with a small stick of amber which has been rubbed and thus electrified. We first place the magnetic needle at zero by allowing it to take its actual position in the meridian, drawing off the rod D and turning the box until the needle and the frame R are in the same plane, and the needle is now at the zero point of the scale. We again put the metal rod against the needle so as to charge it by means of the amber piece as above stated and then remove the rod, and the needle now takes a deflection due to the charge. We then note the spontaneous fall of the needle towards zero by its discharge, taking the time from one division to another. We then find the time needed for the same fall when the standard substance is placed in the box. Lastly we do the same for the test substance, and the proper formula shows the radio-activity of the substance with relation to unity.

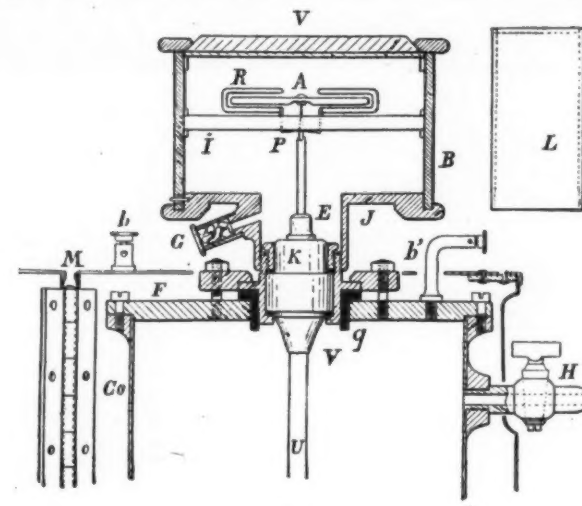


Fig. 5.

When measurements are made with substances whose emission consists essentially of β or γ rays, it is of advantage to use an ionizing chamber of some height. We unscrew the bottom of the box and replace it by a cylinder N (Fig. 4), also extending the needle system to the bottom by means of the metal rod t, which if desired can be terminated by an aluminium plate p at the lower end. The bottom of the apparatus is screwed into the end of the cylinder.

A special condenser device is used for gases or liquids. The condenser is made so that it can be connected with the necessary apparatus without needing to be opened, so that we avoid all loss of gas, and this latter cannot enter the measuring device. Referring to the photograph which shows the measuring box or radioscope mounted on the top of the condenser chamber, we take off the bottom of the radioscope and fix the latter on the condenser (Fig. 5) after previously removing the upper stopper of the latter and placing instead the junction piece J provided with the dessicator G. The cover of the condenser carries the insulating amber bushing K, traversed by the discharge rod U, which descends to the bottom of the cylinder. The rod projects above at E and makes contact with the needle portion. The cylinder carries two cocks H (Fig. 5 and both shown in Fig. 6), H serving for the introduction of the radio-active gas, and it is almost entirely surrounded by an outer metal cylinder M which is insulated from it. The two cylinders are provided with the binding posts b and b'. Such apparatus allows of two different methods of measurement. First, we observe the fall of the charged system towards zero, and in this case the binding posts b and b' are connected together. Second, we connect the interior cylinder (or main condenser cylinder)Co to a high tension battery by the binding post b, and the other post b' and the outer cylinder to the ground. It is to be noted that the amber bushing K is insulated from the condenser cover E by means of a guard ring composed of an ebonite bushing g and a metal sleeve V. By this second method we can observe the increase of the charge across the mass of ironized gas. A storage battery of 400 volts is preferably used here, or a battery of small dry cells for outside work.

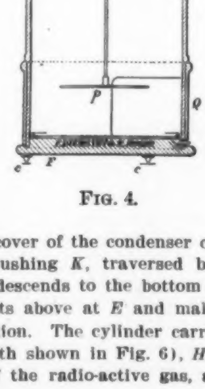


Fig. 4.

The present apparatus is very sensitive and it is designed specially for use with feebly radio-active substances. If the activity reaches one-quarter that of uranium or above that value, we operate as follows: Should the matter be very active and its radiation consist mainly of α rays, we use in this case a much reduced surface of it and compare this with the activity of the same quantity of uranium spread over the same surface. Second, where the matter is very active and its radiation consists largely of β or γ rays (as is the case of radium), we use the ionizing chamber mentioned above. It is of advantage in this case to use as a support for the test matter a special device having a small disk with a cover having a central opening. This cover holds against the disk a screen of suitable metal such as aluminium, for β rays, or lead for γ rays. The same arrangement will serve for the study of absorption of rays by different kinds of screens. When we have to observe relatively strong emanations or examine active products currently or check these up, the needle can be replaced by one which is more strongly magnetized and has a large mass. Thus with the same apparatus we have a wide range from small values up to very high radio-activity.

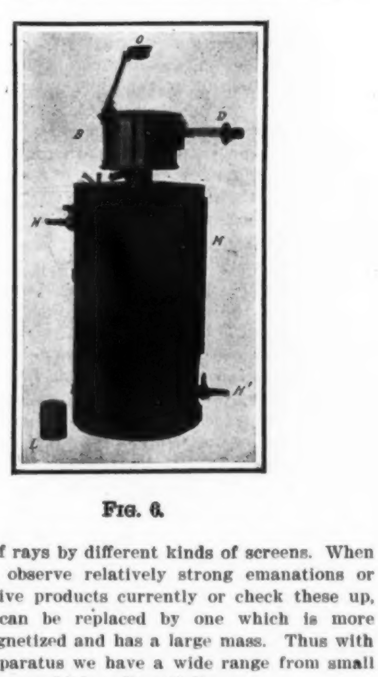


Fig. 6.

LIGHT AND ELECTROMAGNETISM.*

ELECTRIC WAVES AND THE ELECTROMAGNETIC THEORY OF LIGHT.

Concluded from Supplement No. 1804, Page 71.

In opening the second lecture of his course on electric waves and the electro-magnetic theory of light, Prof. Sir J. J. Thomson, F.R.S., recalled the fact that in his previous lecture he had considered the electrical oscillations which occurred in the connecting wire when the inner and outer coatings of a Leyden jar were discharged through it. He had shown then that in such case a current passed through this wire first in one direction and then in the other, and that the rate at which the direction changed was extremely rapid. In the case of the comparatively large jars used in his last lecture the changes took place at the rate of 50,000 to 100,000 per second.

In that lecture, he proceeded, the processes occurring in the connecting wire had been considered, but not what happened in the air in the neighborhood of this wire. On the present occasion he proposed, however, to consider the state of the medium around the wire, which was the seat of phenomena equivalent to electrical waves. Electrical oscillations in the wire, in fact, implied waves in the surrounding medium, if it were assumed that electrical and magnetic effects were propagated with a finite velocity.

Consider, for instance, he said, the wire connecting the two coatings of the jar. If the electric and magnetic effects of the oscillations spread out with a finite velocity, then we could see at once that the state of the surrounding medium must be irregular, positive and negative effects alternating with each other. Such effects might be appropriately called "electric waves." If, for instance, the velocity of propagation were 1 foot per second, then at a point 3 feet distant at any instant the effects to be observed there corresponded to the effects existing in the wire three seconds previously. If another point were chosen 2 feet distant from the wire, the effects to be observed there corresponded to the state of the wire two seconds before. If then, at three seconds before the instant of observation, the current flowed round the circuit in one direction, and two seconds before in the opposite direction, the effects to be observed at a given moment at the two selected points would be, say, positive at the 3-foot point, and negative at the 2-foot point. There was thus a certain periodicity to be found in the medium, the effects in which were thus equivalent to waves.

He proposed that afternoon to connect the two conditions in the wire and in the surrounding medium by means of experiment, though historically this course was wrong. In fact, the history of electric waves afforded one of the most remarkable instances of predictions made by mathematical theory. Maxwell, almost from the beginning of his scientific career, had adopted the view that electrical and magnetic effects traveled outward from their origin with the velocity of light. In his celebrated paper published in the *Philosophical Transactions* in 1865 he had laid down definite equations connecting electrical and magnetic effects. His views at first met with little approval and with scarcely any support on the continent, and, to speak mildly, they were not universally accepted at home. It was, indeed, hardly to be expected that men trained in one way of looking at electrical phenomena, and accustomed to regard it as sufficient for the phenomena then known, should give up this view for one strange to them and unsupported by experimental evidence. After the publication of Maxwell's' book on "Electricity and Magnetism," in 1870, the new theory received greater recognition, particularly among the younger men, in whose minds it had not to suffer from the competition of the older theories. Many of us, Sir Joseph continued, were therefore not much surprised when a most remarkable series of experiments by Hertz gave direct evidence of the existence of electrical waves. When these experiments came to be examined into and discussed, it was found that they fitted in, in all respects, with Maxwell's requirements. The theorist had, in short, seen and predicted the whole field of the phenomena. This fact, the lecturer continued, was, he thought, the most remarkable prediction ever made in mathematical science, transcending the discovery of Neptune from planetary perturbations, as also the other well-known instance of the conical refraction of light.

He would, he proceeded, try to show experiments indicating the existence of electrical waves in the neighborhood of the jars, which he had shown discharging in his last lecture. The great difficulty—and from personal experience he spoke feelingly—was to discover some instrument capable of detecting the effects. It was anticipated that these effects would be propagated with the velocity of light, or 180,000 miles per second. Hence with waves even a mile in length it was necessary to have a system which would not take more than 1/180,000 of a second to vibrate. Waves a mile long could not be dealt with in the laboratory, and it was necessary therefore to find a system which would vibrate millions of times a second, and register movements reversed at this rate. This was the great obstacle to progress, and Hertz solved it by a simple and, in his hand, very effective piece of apparatus. It consisted of a circle of wire not quite complete, but broken by a small gap. When placed near an oscillating circuit, tiny sparks crossed this air space, and it was by studying the variation in the brightness and length of these sparks that Hertz carried out all his remarkable experiments. It was a great tribute to his skill that he got his magnificent results with this crude piece of apparatus. Anyone who had worked with a Hertz detector would, the lecturer continued, know the difficulty of drawing any conclusion. Everything was a question of estimating the brightness of tiny sparks less than 1 millimeter long (0.039 inch). It was difficult in such case to avoid deceiving oneself, as was well shown by the history of the N rays. The existence of these were postulated, because the experimenter thought certain small sparks were produced in one position of his apparatus, and not in another, and on these suppositions quite an elaborate theory had been built up. The results were, however, due to the honest self-deception of an experimenter with preconceived ideas, who thus gave himself unconsciously the benefit of the doubt. Yet Hertz, using sparks but little brighter, steered clear through all difficulties, and left us a large amount of knowledge of these electric waves.

He would not, Sir Joseph continued, attempt to show the meeting experiments with the original detector, although Sir Oliver Lodge had done so in that room, but that lecturer had recommended his audience to provide themselves with opera-glasses, and even then it was questionable whether many succeeded in seeing the tiny sparks.

Nowadays, however, there was almost an excess of detectors, many of which had been found infinitely more delicate than that with which Hertz had done his magnificent work. In the first place, he might mention the coherer, an instrument founded on the fact that if metals lay lightly in contact and were placed in the path of the waves, the contact became very much better, and its resistance very much less. After the importance of this instrument was known, several anticipations of it were found. Thus Hughes, the inventor of the microphone, in 1868 found that a tube filled with loose filings and placed near an induction coil had its conductivity affected by the spark. Branley, however, in 1890 was the first to bring the device prominently into notice. The coherer consisted simply of a tube having terminals, the space between which was filled with metal filings. The resistance of this tube diminished when placed in the path of electric waves. The use of a glass tube was not, however, necessary, the lecturer continued. If, for instance, the circuit of a cell was completed through two iron wires placed loosely in contact, but little current would flow. If, however, electric waves were excited in the neighborhood, the contact improved, the resistance diminished, and more current flowed through the circuit. This constituted the simplest form of coherer. The form usually used consisted merely of a series of nickel filings bridging the space between two terminals in a glass tube, these terminals being placed in series with a battery and galvanometer. The instrument had already been shown in that room by Sir Oliver Lodge, and a great deal of work had been done on it, but even now physicists were not agreed as to its mode of action. Perhaps, indeed, it acted in several ways. Sir Oliver Lodge had called it a coherer, because the thought that tiny sparks passing across the spaces between the filings fused the metal, thus forming a complete metallic circuit. Some such defect did occur in many cases, as seemed to be proved by experiments made in America on the potential difference needed to produce very short sparks. In these experiments very elaborate care was taken to bring opposing surfaces together within a fraction of a wave-length of sodium light. It was found that in such case a comparatively small potential difference sufficed for a start, much less than the 300 volts necessary as a minimum with more widely-separated electrodes. If one of these very short sparks did pass, the two surfaces must, it was found, be withdrawn to three or four times their original distance before the conductivity was destroyed, so that evidently some little bridge was produced by the first spark which had afterwards to be ruptured by pulling the electrodes apart.

Again, when surfaces were very near together, a comparatively small potential difference produced enormous pressures between the surfaces. Taking such a case as one wire laid on top of another, or of filings resting on filings, a difference of potential of 50 volts produced a pressure of 20 to 30 atmospheres pressing the contact closer. Hence it was both possible and probable that the contact points in the coherer were pressed together with very great forces.

Further, if, as there was reason to believe, an electric current were carried by small negative particles, then the proximity of a second surface enormously increased the conductivity of even a very small air space. As a particle shot from a surface, it had to move in opposition to electrostatic forces set up by its own induction on the surface it had left. It therefore experienced a very great force, dragging it back, so that a very considerable velocity was needed for it to get free. If, however, an opposing surface were pushed up, then it got across very easily.

There were, Prof. Thomson continued, some bodies, such as lead in contact with lead peroxide, in which the resistance of the contact was increased by exposure to electric disturbance. The same was the case with pellets of potassium immersed in petroleum. Whatever the explanation of the coherer, the instrument was, he remarked, extremely convenient.

Another form of detector had been devised by Rutherford. This consisted of a few pieces of soft iron wire, magnetized to saturation and placed inside a helix connected to wires exposed to electric effects. These caused currents to flow in the wires, passing backwards and forwards through the spiral, and thus altering the magnetization of the wires. The latter, in fact, lost magnetism, as could be shown by means of a magnetometer, as the lecturer demonstrated. He took, he proceeded, a great interest in this form of detector, because, as used by Prof. Rutherford at Cambridge, it enabled the Cavendish Laboratory to hold for some time the world's record in wireless telegraphy. With it, Prof. Rutherford had successfully signaled between the laboratory and his rooms, a distance of three-quarters of a mile, thickly built over, and he had even obtained indications at the observatory, $1\frac{1}{2}$ to $1\frac{3}{4}$ miles away. This instrument, he might add, provided a metrical method of detecting waves.

By the kindness of Mr. Welch, he was able to exhibit still another form of detector, very interesting, yet very simple. It consisted of a couple of disk electrodes sealed into an exhausted glass vessel. These disks were coupled up with a battery, and a considerable electric field was established between them, but insufficient, in normal conditions, to discharge an electroscope coupled up to one of the electrodes. If exposed to electric waves, however, a discharge passed. For waves having a definite period, this detector proved very sensitive, if coupled up to an inductance and a condenser, giving the circuit the proper period. Its mode of action was not, however, clear, as, under certain conditions, spontaneous discharges passed, although the instrument was not knowingly exposed to electric waves. These spontaneous discharges differed in frequency, and it was possible so to adjust the instrument that the gold-leaf of the electroscope was never at rest. This did not arise from leakage across the glass, but from some change taking place in the gas inside.

Another class of detectors largely used were "rectifiers." They allowed a current to pass through them in one direction only, and thus, though the disturbances to which they were exposed were reversed millions of times, the instrument cut off all those in one direction, allowing only those of contrary size to pass. Such instruments were very well illustrated by crystalline carborundum, which allowed the current to flow along its axis in one direction with great ease, but for contrary currents was almost a non-conductor. Prof. Pearce had, in fact, found that, with a given voltage, nearly 600 times as much current would flow in the one direction as in the other. Another form of rectifying detector consisted of an exhausted tube, one terminal in which was kept red hot, and the other cold. The current would only flow across such a tube when the hot electrode was negative.

Assuming the use of one or other of these detectors he would proceed, the lecturer said, to demonstrate something about the medium surrounding a condenser while being discharged. He had there an exact model

* Engineering.

of Hertz's original experiment, in which two square pieces of zinc formed a condenser, replacing the Leyden jar used on the previous lecture. The condenser was coupled up with an induction coil which caused sparks to pass between balls, and thus discharged the condenser. A point of importance to be remembered in arranging this experiment was that the break which relieved the constraint of the condenser must be extremely rapid. The condenser, having a period of about 1/1,000,000th of a second, must be relieved from its constraint in a very short time indeed. For example, were a pendulum tied up to a beam, it could be started in vibration by cutting the string; but if the latter were slowly untied, it would simply come quietly to rest without vibrating. The release, in short, must be very quick, and in the Hertz experiment this was effected by the spark. The balls must accordingly have no projecting points, for if they had, the electricity would merely trickle across, and the vibration would not be excited. The balls therefore required to be very highly polished; in fact, to have jeweler's polish. As a detector he would use, he said, a very slight modification of that of Hertz, merely replacing the spark-gap by a neon vacuum tube, the brightness of which would serve as an indicator of the intensity of the effects to which the system was exposed. The circle of wire in which the neon tube was included was of the same diameter as that used by Hertz. Hertz first studied the behavior of his detector when the spark-gap was placed in different positions with respect to his condenser circuit. With the plane of the circle parallel to the condenser-discharge circuit, Prof. Thomson showed that the neon tube lit up when it was at either the top or bottom of the circle, but was extinguished when situated at points midway between these extremes. The easiest way of explaining this, he said, was to suppose that during its vibrations the condenser-discharge circuit sent out lines of electric force parallel to the direction of the spark which traveled outwards and fell on the detector. For the tube of the latter to become bright many lines of electric force must fall on it, and these lines were parallel to the line of the balls in the condenser circuit. Hence when the tube was placed parallel to the line of the balls, it was traversed in the direction of its length by many lines, and therefore became bright. In a position at right angles to this the lines of force slipped across the tube, none being parallel to its length, and no luminosity was therefore excited.

A more complicated case arose when the line of the balls lay in the plane of the detector. In such position the wire was able to collect the lines of force, and the tube could accordingly glow, whatever position it occupied.

When a line of force left the exciting circuit it traveled outwards until it met the detector-ring. At this it divided, one portion traveling along one side of the ring, and the other along the other. The two portions running along the wire united at the spark-gap, but in doing so formed a loop which struck back into the spark-gap, whilst the rest of the reunited line traveled on through space. In this rush back into the spark-gap, the direction of the line of fire was reversed.

Hertz's most famous experiment, Prof. Thomson continued, and the one which converted—which was necessary—German physicists into a belief in electric waves was, by the irony of fate, the one experiment which he misinterpreted, and which, if rightly understood, would have been of little evidential value as to the point at issue. This experiment was designed to produce stationary waves, such as were produced in a closed organ pipe by the interference of the incident and reflected waves of sound. He had, he proceeded, fixed on the wall, opposite his condenser circuit, a reflector consisting of a number of metal sheets. Waves falling on this would be reflected, and could interfere with the direct waves from the balls. Following Hertz, he showed that, placing the detector in one position between the vibrator and the reflector, the tube lit up. Moving farther away, the light was extinguished, to reappear again at a point still more distant from the oscillatory circuit. The existence of these nodes and loops, as shown by Hertz, convinced many people for the first time of the existence of electrical waves, the condition of affairs being taken as equivalent to that in an organ pipe sounding a note. At the next lecture, however, he proposed to show a modification of this experiment which would give reason for hesitation in believing that the effect, after all, was really due to the interference of direct and reflected waves.

THE DETERMINATION OF RADIUM.

Some irregularities having been noticed in determining radium by means of the emanation method, Mr. S. J. Lloyd carried out an investigation of the conditions necessary for the accurate determination of radium by this process. Briefly, the latter consists in boiling the solution containing the radium to expel all emanation present, sealing the solution up for a definite length of time, usually several days, to permit the emanation to accumulate, and then drawing off the emanation into a gas-electroscope where its activity is measured. Since in a radium solution which has been freed from emanation the latter grows to half value in 3.75 days, it is possible to calculate the maximum value for the activity from the formula $I = I$ deg. $(1 - e^{-\lambda t})$, where I is the activity observed (the reciprocal of the time of discharge of the electroscope), I deg. the maximum activity, λ the decay constant, and t the time. The electroscope used is standardized from time to time on a solution containing a known amount of radium, and it is therefore possible to determine the actual quantity of radium present in any case. It was found that for the accurate determination of radium by the emanation process, the presence of hydrochloric or nitric acid is essential. If barium sulphate or carbonate be present in the solution, prolonged boiling or repeated determinations are necessary to ensure the extraction of the total emanation. The retention of emanation by freshly precipitated barium sulphate is probably mechanical only, recrystallization under the influence of heat releases the radium, and permits the removal of the emanation.

TO HARDEN HACK-SAW BLADES IN QUANTITIES.

By James Cran.

Blades may be hardened in quantities by using cast-iron boxes of the style shown in Fig. 1, in which to heat them. The boxes should be large enough to accommodate about three dozen blades placed on edge with the back down. A little charcoal should be used at the sides to keep the teeth of the outside blades from coming in contact with the sides of the box. The blades are then placed in the muffle of a furnace and allowed to remain until they have reached the proper temperature for hardening. They can then be removed with a pair of tongs made to fit the shanks on the ends of the boxes. The blades should then be carefully dumped on the inclined chute of a linseed oil bath, which is shown in Fig. 2. The tank containing the oil is placed inside a wooden tank which is filled with water which keeps the oil from getting overheated. Water is supplied through pipe A, and strikes directly on the lower side of the chute down which the blades slide on their way to the bottom where they collect in a wire or perforated sheet metal basket B. An overflow pipe C is placed at one end of the water tank to carry off the warm water which rises to the top. The oil tank should rest upon legs several inches long, so as to raise it above the bottom of water tank to allow a free circulation of the water. When the blades are fairly cooled off, the basket containing them can be removed from the oil and allowed to drip over the tank until most of the oil has left the blades; they can then be thoroughly cleaned by being immersed in a soda kettle or by placing them in clean sawdust. Flexible blades are treated differently, they being hardened on the teeth only. A fixture of the style shown in Fig. 3 is used for this method of hardening. The blades are placed, back down, between two power-driven rolls A which rotate in different directions, and which feed the blades, by friction, between two guides B and past the flame from a gas torch which heats the teeth sufficiently for hardening. A compressed air jet strikes the hot teeth immediately after they pass the torch. The temper does not have to be drawn on blades hardened by either process, except at the ends, which is usually done with a torch.—Machinery.

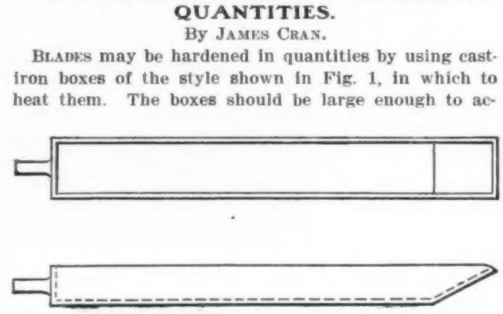


Fig. 1—CAST IRON BOX IN WHICH BLADES ARE PACKED AND HEATED.

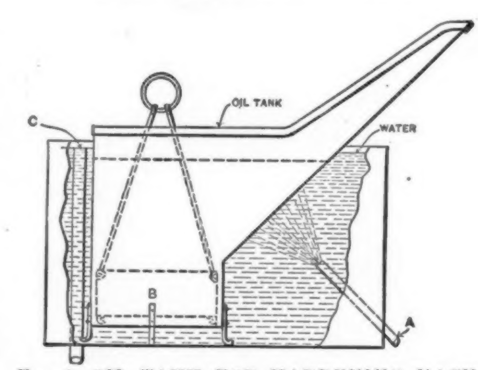


Fig. 2—OIL TANK FOR HARDENING HACK-SAW BLADES.

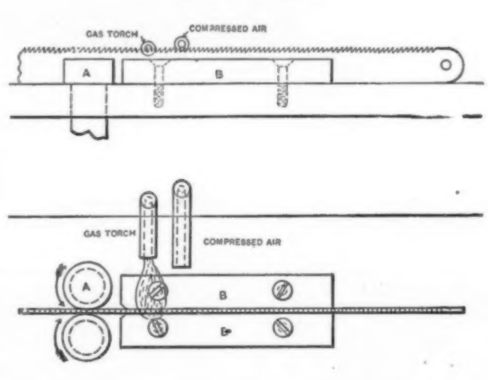


Fig. 3—METHOD OF HARDENING FLEXIBLE HACK-SAW BLADES.

SPENT TAN AS A FUEL.

In the School of Mines Quarterly, Mr. D. M. Myers gives some results of numerous practical trials of spent tan for steam-raising purposes.

The material, in both pressed and unpressed condition, was used alone and in admixture with wood and coal. The boilers were of the horizontal tubular kind, the construction of the furnaces, method of stoking, etc., being variously modified during the progress of the investigation. The spent tan as obtained in the fire-room contained about 65 per cent of moisture, its weight averaging 2.13 times that of the air-dry bark ground at the mill. The available heat value of the air-dry bark being about 5676 British thermal units per pound, that of the spent tan averaged 2665 British thermal units per pound, and the degree of leaching was found not to influence the heat value of the spent material, except in so far as it affected the actual weight. The percentage composition of a representative sample of spent hemlock tan was found to be 51.8 of carbon, 6.04 of hydrogen, 40.74 of oxygen, and 1.42 of mineral ash. As the result of tests made with wet spent hemlock tan in a typical installation at a tannery, the combined efficiency of boiler and furnace was found to be 58.2 per cent, based on the available heat value, and 43.9 per cent calculated on the total heat value, of the fuel; while, when an automatic stoker furnace designed by the author was employed, the efficiency figures obtained were respectively 71.1 and 54.4 per cent. The increase in available heat obtained by pressing the spent tan before burning was found to be about 1¼ per cent for each per cent of moisture expelled; but the amount of moisture retained rarely falls below 58 per cent, and since pressed tan burns more rapidly than the unpressed material, a corresponding reduction in grate area is necessary in order that pressing may be advantageous in practice. In a series of comparative tests it was found that the addition of about 1 part by weight of coal to 6 parts of pressed tan increased the combined thermal efficiency of furnace and boiler from 59.4 to 63.4 per cent, the percentage rated capacity of the boiler being increased from 92 to 135.5. When wood was mixed with the tan for firing, the best results were obtained by grinding the wood to the size known as "hog-feed," the presence of logs or slabs of wood being found disastrous both to the furnace and to combustion. Mr. Myers finds that ample combustion space is necessary for the satisfactory burning of tan, and for this reason regards low-arched furnaces as unsuitable for the purpose. He also finds that tan cannot be burned economically in an ordinary coal setting without a refractory arch separating the fire from the cooling surface of the boiler shell or tubes, this being the case both for hand firing and automatic stoking, even when the tan is enriched with coal in such proportion that the heating values of the two fuels are equal. Under normal conditions, the boiler horse-power per square foot of grate was found to be about 2.08 for oak tan and 1.5 for hemlock tan, these values being very largely influenced by the comparative excellence of the firing. The author concludes that, basing comparison on flue gas analyses, the combustion of tan is more complete than that of coal under equally favorable conditions. The high moisture content of the tan, however, produces a comparatively low furnace temperature, and acts against an equally high combined efficiency of furnace and boiler.

Many improvements and extensions have been carried out during the past five years all over the Montreal street railway system, and all have been in keeping with this growth and expansion of Greater Montreal. New lines have been extended in every direction to meet the growing demands of traffic, while the rolling stock has been added to by the most modern and commodious cars. This, together with the policy of economy practiced by the management, has added largely to the earning capacity of the company, which is shown in the remarkable increase as compared with recent periods.

RECENT PROGRESS IN AVIATION.—III.*

THE PRESENT STATE OF THE ART.

BY OCTAVE CHANUTE.

Continued from Supplement No. 1804, Page 74.

THE next man who began experimenting was Mr. Esnault-Pelterie, a young French civil engineer, who started out with gliding machines, and then built a monoplane. Fig. 19 gives a view of the 1908 design. That is the machine as finally perfected. He has made quite a number of flights, but no very long ones nor any high ones, the highest being 100 feet.

Capt. Ferber, who is next to be mentioned, has been the chief apostle of aeroplanes in France. He became interested in the subject at an early date (1898), and has been promoting aeroplanes ever since. He began with gliding experiments. At first he was greatly in favor of the monoplane, but when I explained to him the advantages of the biplane, he accepted that design, although he did not like the stiff, horizontal lines, and introduced bird-like transversal curves. Then he added a motor; this was applied to the No. 9 machine, in

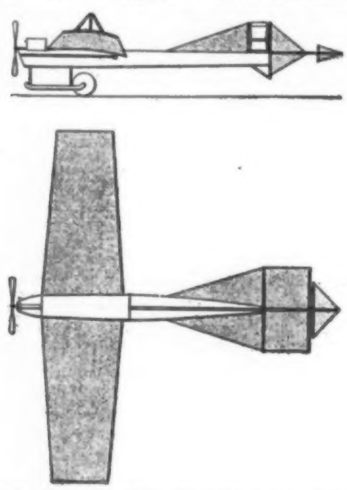


FIG. 19.—PLAN AND ELEVATION OF THE ESNAULT-PELTERIE MACHINE.

which he still had these transversal curves in the wings; he had the propeller in front, and instead of twisting the wings he used fins at the rear, which are adjustable. He obtained some very fair results. This machine is shown on Fig. 20. On the 5th of September, 1909, he borrowed a Voisin machine and undertook a trial flight at Boulogne, preliminary to attempting to cross the British Channel, where it is about 40 miles wide, but, in making a turn, his machine tipped over unduly to the left. He undertook to alight, but in doing so his left wing struck a lump of earth, or hummock, when the wheels rolled into a ditch, the machine turned turtle, and poor Ferber was killed, to the profound sorrow of all interested in aviation. He is the third victim thus far this year[1], but wonder all along has been that so few accidents have occurred. There have been thousands of flights made—for instance, 1,300 were made in one week at the Rheims tournament—but thus far only three deaths have occurred.

More people kept coming into the field and among the later ones is Mr. Hubert Latham, with a monoplane called the "Antoinette." Mr. Latham has risen to sudden prominence by some daring feats. Mr. Levavasseur designed and built this monoplane and engaged Mr. Latham to operate his machine. With it Mr. Latham got some very fine flights, such as that shown in Fig. 21 taken at Rheims. On the 6th of June, 1909, he went across the country 10 miles from Juvisy. On the 19th of July he attempted to cross the British Channel, but was unsuccessful. On the 27th of July he tried it again, and flew 20 miles, or within one mile of Dover. The motor then gave out and he fell into the sea. The flight is pictured in Fig. 22. On the 26th of August, at the meeting at Rheims, he flew 96 miles in two hours and 18 minutes, and won the

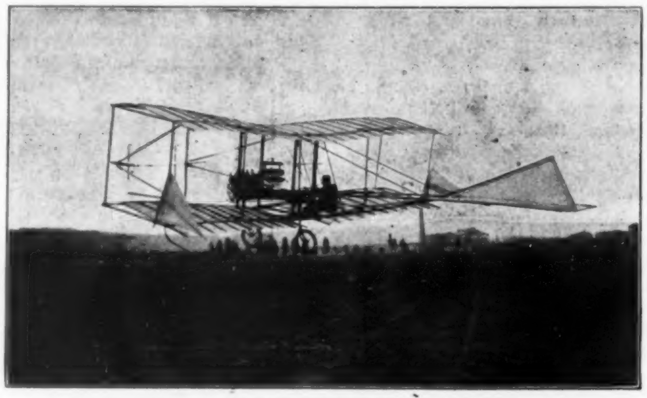


FIG. 20.—FERBER'S BIPLANE IN FULL FLIGHT.

FIG. 21.—LATHAM (AT TOP). LEFEBVRE AND BUNAU-VARILLA.

* Paper read before the Western Society of Engineers, and here reprinted from its journal.

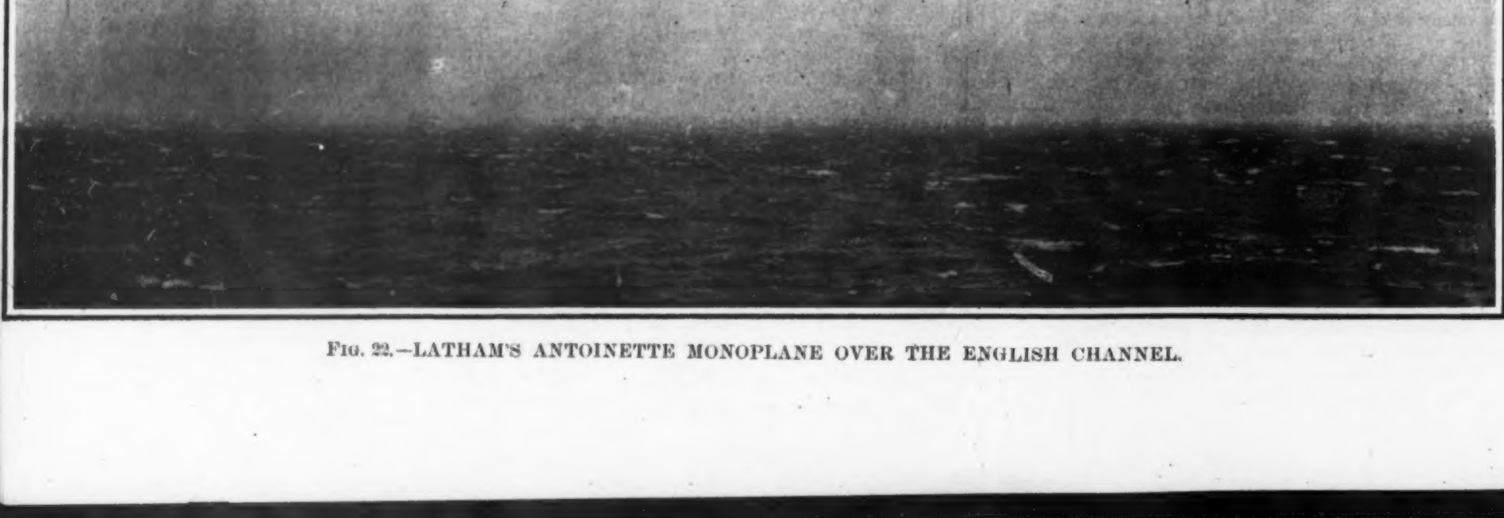


FIG. 22.—LATHAM'S ANTOINETTE MONOPLANE OVER THE ENGLISH CHANNEL.

second prize for distance. On that occasion he rose 508 feet, a record which has since been beaten by Paulhan and Rougier, who have developed an extraordinary aptitude for high flights.

On his first attempt, on the 10th of July, 1909, Paulhan was able to fly 1.25 miles. On the 19th of July he flew 12 miles across country; on the 7th of August, 23 miles; on the 24th of August, 18 miles on a Voisin machine, and on the 25th of August he flew 81 miles at Rheims, winning third prize for distance. He has since made very fine flights in various meets. Fig 23 is from a photograph taken at Juvisy.

The next man to reach prominence is Mr. Sommer. On the 4th of August, 1909, he flew 2 hours; on the 7th of August, 37 miles at Rheims; on the 10th of September, 18 miles over troops in review; on the 11th of September, 24 miles, from Nancy to Lenoncourt. Fig 24 shows a flight in company with Farman.

E. Lefebvre, an automobile dealer, having purchased a Wright machine, laid down lines of rails and taught himself how to operate and fly the machine. At Rheims he made some very good performances. On the 27th of August he flew 12.5 miles in 20 minutes and 7 seconds. Unfortunately, upon the 7th of September, when testing a new Wright machine, he was upset and ...ed, this being the first fatal accident to occur in ...9.

...ne of the last men to come into prominence in ...nce has been Mr. Henri Rougier, who operates a ...sin machine, Fig. 25, and who has made some remarkable high flights. At Brescia he reached 328 feet of altitude, and later, on another occasion, 650 feet of altitude was reached. At Berlin he won the first prize for distance. On the 18th of October, at Blackpool meeting in England, he made a flight of 18 miles in 25 minutes, but all of those performances in height fall far short of the performances of Orville Wright, who rose to a height of 1,600 feet.

By the contract in which the Wright brothers agreed to sell their French patents to a syndicate, Mr. Wilbur Wright was to teach three pupils to operate the machines. The men selected were the Count de Lambert, Mr. Paul Tissandier, and Captain Lucas-Girardville. The latter, being an army officer, has not appeared in any public tournament, but Mr. Tissandier has made many good flights, the longest up to the present time being one of 69 miles at Rheims and he has been training pupils of his own. Count de Lambert made a flight of 72 miles at Rheims, and day before yesterday (October 18th) he made a sensational journey from the aviation grounds at Juvisy, where Fig. 26 shows one of his flights, over a portion of Paris to the Eiffel tower and

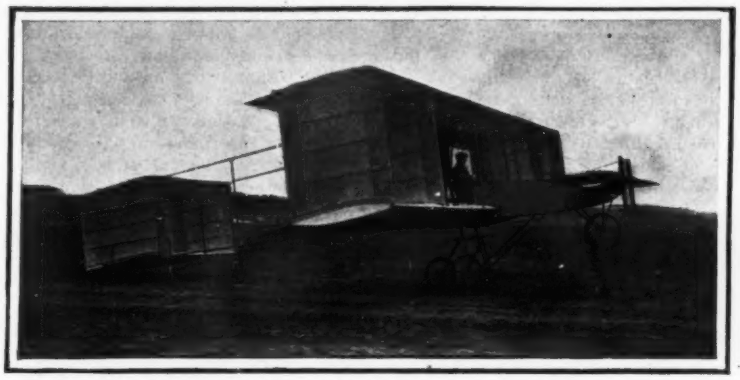


Fig. 25.—ROUGIER'S VOISIN RISING FROM STARTING GROUND.


Fig. 23.—PAULHAN ON VOISIN MACHINE AT JUVISY.

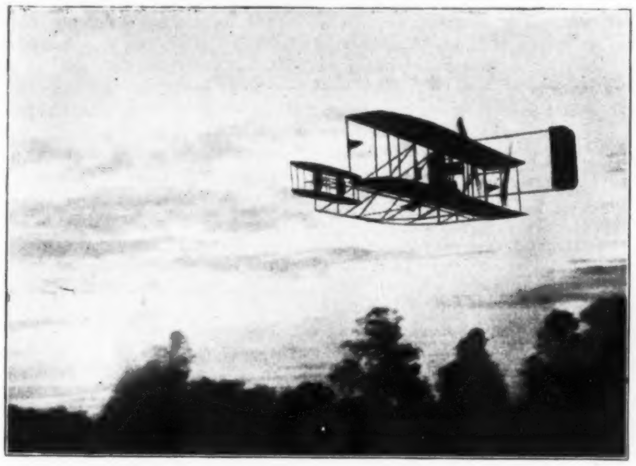


Fig. 26.—DE LAMBERT ON WRIGHT MACHINE.

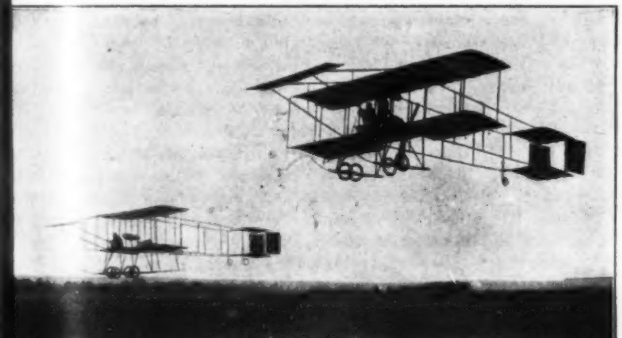


Fig. 24.—SOMMER AND FARMAN IN RACE.

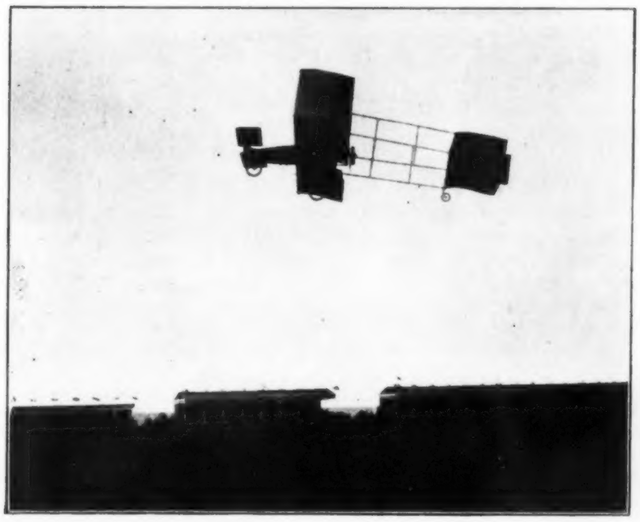


Fig. 27.—BUNAU-VARILLA ON VOISIN BIPLANE.

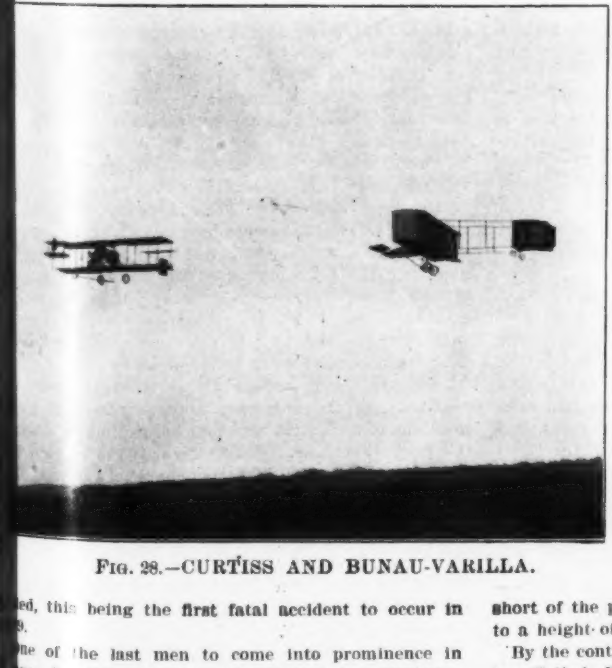


Fig. 28.—CURTISS AND BUNAU-VARILLA.


Fig. 29.—THE "JUNE BUG" AT HAMMONDSPORT, N. Y.

back, some 30 miles. This feat, as well as the flight of Latham, on September 27th, over the suburbs of Berlin, is disfavored by the Wrights as involving undue risks of accident.

Wilbur Wright also taught two pupils in Italy (where he sold a machine)—Lieutenant Calderara, who flew at Rome and at Brescia, winning some prizes and meeting with accidents, and Lieutenant Savoya, whose performances have not been made known.

Mr. Legagneux and Mr. Bunau-Varilla also made creditable flights at Rheims upon machines built by Voisin brothers, but the performances most commented upon at that tournament were those of Mr. Glenn Curtiss, who, with a machine built by himself, won the Gordon Bennett cup by making the shortest time over 20 kilometers; won the first prize for speed in a flight of 30 kilometers (46 miles an hour), and the second prize for speed over 10 kilometers, in which he flew at 48 miles per hour. Figs. 27 and 28 show these flights. Subsequently, Mr. Curtiss won the grand prize at the Brescia meet by flying 31 miles in 49 minutes and 24 seconds. He had previously won twice the Scientific American trophy in this country, once, July 4th, 1908, by a flight of 5,090 feet at Hammondsport, N. Y., and again, July 24th, 1909, by a flight of 25 miles in 52 minutes and 30 seconds.

This was the direct outcome of the labors of the Aerial Experiment Association, organized in 1908 by Alexander Graham Bell, upon the suggestion of Mrs. Bell, who generously contributed the funds. Dr. Bell had been experimenting with groupings of tetrahedral kites which exhibited extraordinary steadiness in the air. He hoped to develop them into an efficient flying machine of automatic stability, and had been well served in his experiments by two young Canadian engineers, Mr. F. W. Baldwin and Mr. J. A. D. McCurdy. In order to give these faithful men a chance to test their own ideas, the Aerial Experiment Association was organized by taking in (besides the three named) Lieut. Selfridge and Mr. Curtiss, the latter then being a manufacturer of motor-cycles and motors at Hammondsport, N. Y., where the experiments were first started. The association built four flying machines—the "Red Wing," the "White Wing," the "June Bug" and the "Silver Dart"—all of double-bowed shape shown in Fig. 29, and equipped with Curtiss motors. With these some very promising flights were made, both at Hammondsport and at Baddeck, Nova Scotia, to which place the association moved and where Mr. McCurdy made flights of 16 miles and over.

(To be continued.)

AEROPLANES AT RHEIMS.

THE LESSONS OF THE GREAT AVIATION MEETING.

If the progress of aviation were to be judged from the general design of the machines taking part in the Rheims meeting, it might be concluded that the advance made during the past year had not been so rapid as would seem to be warranted by the growing popularity of the flying machine. The same makes and same types of aeroplanes that competed on the previous occasion were there, together with a number of new mechanisms, which, however, failed to distinguish themselves, and the honors were carried off by the well-known Blériot and Antoinette monoplanes, while the biplanes failed to secure any of the big prizes. Yet despite the absence of any departure from the generally accepted lines of flying-machine construction, the results obtained at Rheims were extraordinary. Makers have secured these results by learning from experience how to refine their existing machines and get the most out of them. This is a safer and surer process than launching out upon new machines designed in accordance with new principles, for however good the principle may be, the refinement must take time, and it is probable that a vast amount of practical work will have to be carried out before the present types of monoplanes and biplanes lose their supremacy. There are scores of machines in France being experimented with in secret. Many have failed, and others are being constantly modified, but even these failures are providing valuable experience which may serve to advance the cause of aviation. At Rheims there was novelty in the De Pischoff and Breguet aeroplanes, but though both were successful, they have as yet done nothing in the way of "good performances." The De Pischoff monoplane is an Austrian machine which owes its novelty to the fact that, instead of having a tractor propellor, as in all other monoplanes, it has the propeller behind the plane. The frame, carrying the engine and two seats side by side and terminating in a tail with horizontal and vertical planes, is well down below the main plane, the idea being apparently to lower the center of gravity. This is entirely at variance with the theories of French builders. Herr Pischoff has evidently not yet settled upon the most suitable type of plane, for on one of the machines the plane curves upward at each end for the purpose of increasing stability, and the other is of the Blériot type. The Breguet is a biplane with Gnome engine and tractor propellor with three aluminium blades geared down to about 600 revolutions a minute. Most of the new flying machines combine the features of well-known types of aeroplanes. The Hanriot has a Blériot plane and Antoinette body. The new Voisin biplane, in which the vertical planes have been suppressed, has a steel tube frame, and steel tubes are also employed in the construction of the Goupy machine, the characteristic feature of which is that the two planes are not in the same vertical axis. In the Savary biplane there are two tractor propellers driven by chains. There was thus plenty of variety in the position and arrangement of propellers and planes, but all these machines were hopelessly overshadowed by the Blériot and Antoinette. The only thing that stands out is the suppression of the cellular biplane, the vertical planes having been done away with because they slowed the machine without providing any adequate compensation in increased stability. For the moment the stability of aeroplanes is very relative, and automatic stability is something of a myth.

The way in which the monoplanes swept the board at Rheims was startling, because very little had been heard of them for months previously, and until then the biplanes had carried everything before them. This was due simply to the fitting of high-powered engines to the machines and to the weather being for the most part unfavorable to the biplanes. The exploit of Latham at Blackpool last year, when he showed what could be done with a monoplane in a gale of wind, demonstrated the importance of high speeds. Blériot went still further and fitted some of his machines with Gnome fourteen-cylinder engines rated at 100 horse-power and driving 2.50 m. propellers at 1300 revolutions per minute. The problem of propeller efficiency does not seem to have made much headway. Pending its solution makers are content to increase the powers of their engines in a much higher proportion to the gain in speed. The only limit is the capacity of the aeroplane to resist the strains and stresses, and the higher consumption of gasoline is more than compensated for by the greater load which can be carried, thereby allowing of greater reserves of fuel for longer flights. When the limit of speed has been reached propeller efficiency, and particularly the application of power, will become a vital question. With an augmentation of engine power in the Blériot aeroplane the sustaining surface has been reduced to 12 square meters.

Much, of course, has been learned about the theory of plane curvature during the past year. It is now common knowledge that the factors of sustaining power and the advance of the plane against air resistance are conflicting, and the design of planes must necessarily be more or less of a compromise. The planes on the machines piloted by Morane and Leblanc were quite flat. In the Blériot the surface of the flat main plane has been considerably reduced, and webs have been added to each side of the frame from the main plane to the tail. In some of the Blériot machines the frame is entirely covered with rubber fabric to diminish air resistance, and the pilot sits inside with only his head projecting from the top. With his new 100 horse-power aeroplane Morane attained a speed of 66 miles an hour, while Olieslaegers, also on a Blériot, remained in the air 5 h. 3 min., during which time he covered 244 miles. It is to be noted that these speeds and distances are official, and were certainly exceeded, since the aeroplanes must have added to their totals when turning the standards which marked the course on the Betheny plain. The course was, moreover, much smaller than on the previous occasion, and the larger number of turns increased the distances actually covered. We may therefore take it that Morane's speed was about 70 miles an hour, and as the lifting power increases in a high ratio with the speed, he was able to carry sufficient fuel for long journeys. This result has been obtained in the Blériot by more than doubling the engine power, while the increase in speed has been 35 per cent. It is difficult to see how the sustaining surface can be reduced much more, and the ratio of power to speed has become so high that it is probable a limit has almost been reached in this direction with the existing combination of engines, propellers, and planes.

The Antoinette monoplane has not undergone much change, and its performances at Rheims were consistent, throughout; but unfortunately, a sufficient margin does not appear to have been allowed in the construction of the machines for the higher speeds. As the planes are simply recessed in the body and held by wire stays, too much importance cannot be attached to the system of lugs and joints employed, for these support the whole of the effort. It is quite possible that the accident which proved fatal to Wachter was due to the wires being torn away from the joints, when the planes became detached. A similar accident happened to Thomas, but as he was at that moment only a few feet above the ground he escaped serious injuries. Otherwise the Antoinette machines entirely maintained their reputations for speed and apparent stability, and were only beaten by the new Blériots with a smaller surface and much higher engine powers.

The striking superiority of the monoplanes at the Rheims meeting was, as we have said, due solely to their high speeds enabling them to make headway against the heavy winds that blew intermittently during the greater part of the week. There was no lack of excitement while the Blériots and Antoinettes battled with the gale. Not long ago it would have been regarded as impossible for flying machines to live under such conditions, but while they have been given the speed enabling them to vanquish high winds, it must be concluded that the greatest factor is the pilot himself. Flying under these conditions necessitates a concentration of mind, coolness, and rapidity of action which are not possessed by everyone, or even by all airmen, and the pilots themselves recognize the dangers of their calling. Flying in a gale of wind constitutes risks which only expert professionals care to run. The biplane is usually regarded as a much safer and more manageable machine, and one of the main arguments put forward in favor of this type of apparatus is that it may be driven by almost anyone after a short apprenticeship. But while the biplane is undoubtedly easier and safer to handle, the experience of the Rheims meeting shows that it is far more dangerous than the monoplanes in high winds. On some days when the monoplanes were flying the owners of biplanes did not care to take their machines out of the sheds. With the wind blowing at from four to five meters a second, however, the biplanes flew, but they were frequently carried out of the course, at times turning almost round, and several were turned over and collapsed. Fortunately, pilots took the precaution of flying close to the ground, and not much personal injury was sustained. This did not save the Baroness de la Roche, who was piloting a Voisin biplane, which has the reputation of possessing a certain automatic stability, and her machine smashed to the ground, when the lady was so badly hurt that it was feared at first she could not possibly survive. This, however, was not due to the wind, which was only very moderate on the day the accident happened, and while some assert that the machine was caught in a whirl caused by the too near approach of a competing aeroplane, others are of the opinion that the engine suddenly stopped, and the aeroplane dived to the ground. The latter supposition seems to be the most strongly borne out by the evidence. But if the biplane was eclipsed at Rheims it does not follow that the system itself is inferior to the monoplane. It is true that it offers much greater resistance to the air than the single plane machine, but it is also propelled by much smaller engines. While these engines develop 50 to 60 horse-power, the power actually utilized is not more than 30 or 40 horse-power, although at the Rheims meeting some of them were undoubtedly running with almost their full power. The biplanes had from three to four times the supporting surface of the small Blériots. Obviously there are much greater possibilities of development in the biplane than in the monoplane. In the latter machine further progress depends simply upon propeller efficiency, but in the biplane there are all sorts of combinations possible, and the propellers may be placed in many positions to secure the maximum propelling effort with the power available. Simply because the biplane has a larger surface than the monoplane it can never progress so fast, unless this can be done by an arrangement of propellers which will utilize the power for driving under better conditions than the tractor screw on the monoplanes; but, on the other hand, there is no reason why the speed should not be high enough to enable the biplane to fly in all weathers. At present its speed is about forty miles per hour, but this will certainly be increased to fifty and sixty miles, when the biplane will be able to hold its own even in a gale of wind. The Rheims meeting marks an interesting

phase in the science of aviation, since the speeds obtained with powerful engines and small flat planes will certainly open up the field of research, and will probably suggest modification in biplane construction.

As regards engines there is very little novelty, but a good deal of improvement has been made in the well-known types, such as the Gnome, E. N. V., Clerget and Antoinette, which have given evidence of increased reliability. Considering the engine troubles at the previous meeting, the progress in this direction is gratifying. The only danger now lies in an engine seizing and capsizing the machine. If it should simply stop, airmen safely glide to earth, and it is this accomplishment in gliding which has enormously increased the safety of aeroplanes and encouraged pilots to fly to previously unheard of heights. In propellers it does not seem as if much has been done, and nearly all aeroplane builders are at the moment running their propellers at high velocities. This is a problem which must be solved in the early future.

The performances at Rheims show that a great deal of useful work has been done in increasing the value and scope of aeroplanes. The fact that Olieslaegers should fly 244 miles in five hours is proof that the machine in its present form possesses practical value. A cross-country race, when the aeroplanes were started together in heats of three, was contested without the slightest accident and awakened a vast amount of public interest. There was a competition for officers piloting aeroplanes, and quite a number of machines flew across country with passengers. The most sensational performance, however, was accomplished by Latham on his Antoinette machine in the height competition, when he reached an altitude of 1513 yards. At that time the weather was stormy and the sky was covered with dense black clouds. Latham, as well as Morane, disappeared in the clouds, and Latham declares that having nothing to guide him he lost all sense of the horizontal. He admits that he experienced a very trying time until he got clear of the clouds. These performances in height, speed, and duration have given much food for thought to those who have been discussing the relative value of aeroplanes and dirigible balloons for military purposes. What chance, it is asked, can a dirigible balloon have when an aeroplane flying at seventy miles an hour can circle around it at any height? The disasters to the dirigible balloons in Germany have considerably cooled the ardor of the French for "aerial warships," and their confidence is not strengthened by the keeping of the balloon in their sheds until the weather should become fine. Meanwhile, aeroplanes have been flying in gales of wind, and thus demonstrating their ability for scouting in the worst of weathers. At the present moment the French army could mobilize more than a hundred aeroplanes, all in the hands of capable pilots.—The Engineer.

BILLIONS INVESTED IN ELECTRICITY.

THE LATEST CENSUS RETURNS.

THE magnitude of the central electric station industry in the United States in the census year 1907 as compared with the census year 1902, and the growth during the intervening five-year period, are shown in the Census Bureau's special report, now in press, on the second United States census of the Central Electric Light and Power Stations for the year 1907, prepared by William M. Steuart, chief statistician for manufactures, in conformity with the act of Congress of June 7th, 1906, requiring the collection of such statistics at five-year periods.

The central electric stations are defined in the report as those which, exclusive of isolated electric plants, furnish electrical energy for lighting and heating; and power for manufacturing and mining purposes, for street railways and elevators, for charging batteries, etc.

TWO CLASSES OF CENTRAL STATIONS.

Central stations are classed as "commercial" and "municipal"; the former being those operated under private ownership, whether by individuals, companies, or corporations, and the latter being those operated by state, city, or other local governments, except those operated especially for institutions.

The central stations are further classed as "purely electric" central stations, or those that do a strictly electrical business, and "composite" central stations, or those operated in connection with some other industry. It is stated that the majority of the central stations are of the "purely electric" class.

With reference to the municipal stations, the report states that these plants are generally established primarily to furnish current for lighting public buildings, streets, and parks. Their field of operation is, however, much like that of the commercial stations.

The census takes no cognizance of electric stations operated by the Federal Government or of those operated primarily for state institutions.

It is noted in the report that the figures given for the central stations do not represent the entire production of electrical energy. To arrive at the aggregate it would be necessary, it is stated, to consider also the electric railways, telephone and telegraph lines, electric police patrol and fire alarm systems, and the isolated electric plants.

In the first chapter of the report, which is a general discussion of the subject, it is stated that the tendency to sell electricity for general commercial use is constantly increasing among electric railway companies.

In 1902 there were 251 railway companies which furnished electricity for light, power, and other purposes. These companies reported an aggregate income of $7,703,574 from the sale of current. In 1907 there were 330 railway companies in this class, and the income from the sale of current amounted to $20,093,302.

THE ANNUAL OUTPUT.

In 1902 the annual output of all electric stations and electric railways amounted to 4,768,535,512 kilowatt hours. In 1907 the output of the two classes of stations was 10,621,406,837 kilowatt hours, the increase in that year as compared with 1902 being 5,852,871,325 kilowatt hours, or 122.7 per cent. In 1902 the output by electric railways formed 47.4 per cent of the total, but by 1907 the proportion for such railways had fallen to 44.9 per cent.

Consolidations of the two branches of the industry and the growing tendency of the railway companies to sell electricity for commercial purposes are referred to in the report, which further states that the separate statistics of the central stations are, therefore, not representative of all the electrical energy sold for general commercial purposes. It is observed that during the five years ending with 1907 the central stations increased more rapidly than the electric railways.

Regarding the isolated plants, the report states that for the purpose of lighting and furnishing power for factories, hotels, or other enterprises a large quantity of electricity is generated in plants which are operated for the exclusive benefit of their owners. Some of these plants sell limited amounts of current, but they were established as adjuncts to other forms of business, and practically no statistics concerning them are included in the census reports. Some of these isolated plants are extensive and have a much larger capacity than many of the central stations. At the census of 1902 it was estimated that there were 50,000 of these isolated electric plants in the United States.

GREAT INCREASE IN PLANTS.

The number of commercial and municipal plants increased from 3,620 in 1902 to 4,714 in 1907, the increase amounting to 1,094, or 30.2 per cent. The application of the same rate of increase to the estimated number of isolated plants in 1902 gives an estimate of 65,000 for 1907. To what extent the utilization of surplus power in the operation of private electric plants to furnish light and power for large mills, department stores, hotels, and other industrial enterprises has stimulated the increase in these plants it is, the report declares, impossible to state, and notice is given that the estimate, therefore, may be more or less than the actual number of isolated plants in existence.

Referring to power or generating plants, the report states that the number of primary power or generating plants was not called for in the schedule used for reporting central stations in 1907, but some idea of their number may be had from the fact that the returns showed 4,731 plants equipped with dynamos for the generation of electricity. Of the 4,714 stations reported in 1907, 227 had no generating equipment, while 113 had more than one power plant. This latter class reported 357 generating stations.

There were, in 1907, according to the report, upward of 30,000 individuals, companies, corporations, and municipalities, exclusive of isolated electric plants, which reported the generation or utilization of electric current in what may be termed "commercial enterprises."

OVER SIX BILLIONS INVESTED.

These industries represent an outstanding capitalization of $6,209,696,753, of which amount $1,367,338,836 is credited to central electric stations—$3,774,722,096 to electric railways, $814,616,004 to commercial or mutual telephone companies, and $253,019,817 to telegraph companies, the latter item including $32,726,242, the capital stock of wireless telegraph companies. The capitalization of the 17,702 independent farmer or rural telephone lines and of the 1,157 electric police-patrol and fire-alarm systems could not be ascertained. The report states that there are also excluded a number of companies organized for the purpose of acquiring the capital stock or bonds of electric companies, street railway companies, gas and water systems, and similar properties, holding the same for investment and to some extent supervising the operation of the underlying companies; the reason being that to show the capitalization of these holding companies would be misleading as applied to central electric stations, since it would be impossible to determine the extent of its application to the electrical industry as distinguished from others.

THE MUNICIPAL STATIONS.

The report states that the municipal stations are practically exempt from the consolidations that so frequently occur among commercial companies, and this fact no doubt accounts in large part for the proportionately greater increase discovered in the former class of stations. Not only was there a large increase in the number of municipal stations, but an analysis of the report shows that, although 33 municipal stations which reported in 1902 had become commercial stations in 1907, 113 stations which were reported as commercial in 1902 had become municipal in 1907.

The report refers to the fact that claim has been made and sustained by what appears to be reasonable argument, that the drift of these public utilities is from the municipal to commercial, but it is asserted that the results of the census do not furnish corroborative evidence of this. On the contrary, there appears to be a distinct field for municipal electric stations, not only because of the feeling which may exist in many localities that these public utilities should be owned by the cities, but because many of the places in which municipal plants are located do not present sufficient inducement for the investment of commercial capital.

HOW OLD IS THE EARTH?

A NEW calculation of the age of the earth has been made by George F. Becker, who comes to the conclusion that in the stratigraphical method of determining the age of the ocean the weak point is the uncertainty of the duration of pre-Cambrian time. The best determination of the date of the base of the Cambrian seems to be that by Mr. Walcott, who places it at 27,640,000 years ago. The order of magnitude of the pre-Cambrian period is probably the same, so that stratigraphy indicates an age of the ocean of, say, between 50 and 65 million years. This is in accord with Mr. Sollas's most recent results, for he regards 80,000,000 as a maximum without being able to give a definite account of nearly so long a period.

Considering sodium accumulation as an asymptotic process, as it unquestionably is, the weak point is the possibility that the primitive ocean was salt, or that there have been continents in the oceanic basin. These possibilities do not affect an estimate of the maximum age, 74 million years, but preclude a definite minimum. Assuming that neither of these possibilities was realized, the minimum would be about 46 million years, according to Mr. Becker.

Refrigeration, so dealt with as to exclude tidal instability, and computed on the basis of Mr. Hayford's level of isostatic compensation, without employing as a datum any observed superficial temperature gradient, yields results which can hardly be forced above 70 million or below 55 million years. The weak point here is our ignorance of the depth of the top of the diabase couche; but if Laplace's law of density holds true, the limits would be about 65 and 55 million years.

These three methods seem to be inter-confirmatory and to give results which converge toward some value near 60 or perhaps 65 million years.

This being granted, it follows that radioactive minerals cannot have the great ages which have been attributed to them. Only something like a tenth of the heat emitted by the earth can be ascribed to radioactivity plus all other exothermic chemical transformations; the remaining nine-tenths is heat due to compression.

A LOCOMOTIVE SPEED-GAGE.

A NEW ELECTRICAL DEVICE.

BY DR. ALFRED GRADENWITZ.

The novel electrical speed gage, which has been used for some time with good results on the locomotives of the Stettin District of the Prussian Railway Department, is based on the volt-meter principle, and comprises a sending and a receiving apparatus.

The sending apparatus is a small magneto-electrical machine actuated by one of the running axles of the locomotive, to which it is directly connected. This generates alternate currents of a tension which corresponds with the actual speed of traveling, and which acts upon a receiving apparatus or volt-meter installed at the driver's cabin.

As the electro-motive force of a dynamo is proportional to the number of turns of its armature, the deflection of the volt-meter index will allow the number of turns of the axle connected to the sending apparatus, and accordingly the actual speed of the locomotive to be determined.

The sending apparatus, as represented in Fig. 1, consists of a stationary soft-iron pole ring, comprising eight radial pole pieces pointing inward, and bearing each a coil of wire. Inside this ring, or stator, is rotating a composite four pole permanent steel magnet, or rotor, the pole width of which is equal to a coil section.

During the rotation of this rotor there is generated in the stationary coils an alternate current, the tension of which depends on the number of turns of the rotor. Now, as the coils of the stator are connected up alternately in series, and both series in parallel, there are produced two alternating currents shifted in phase through 90 degrees, and which are transmitted to the receiver by three conductors, one of which serves as a common return.

The round casing, made of red brass, is locked by a screwed-on lid, provided in the middle with an hexagonal nut, and which keeps off any water and dust. The pole ring is fixed to the casing by three screws, and the rotor is mounted on an axle having its bearings in its bottom. This axle is secured by a nut, and a check-nut and a peg, and, in addition, carries a junction flange, which is solidly connected with the front side of the locomotive by means of three screws. In order to relieve these screws, and to allow the transmitter axle to be accurately centered in regard to the front of the wheel axle, there is inserted between the flange and axle a special relieving steel ring. The bearing is lubricated by means of a wick, the lubricating vessel being arranged at the top of the casing. The rotor of the sending apparatus thus takes part in any motion of the locomotive axle, whereas the casing, resting on the sender axle with the pole ring and stator coils, is prevented by a lock from participating in the rotation. This lock consists of a horizontal tube fitted sideways to the casing, and the free end of which is fixed to a convenient part of the gear, performing the same motion as the axle, such as the spring holder resting on the axle box. At the free end of an iron strut screwed to the spring holder is fixed a threaded bolt penetrating loosely through the ring at the head of the locking tube. This ring is located between two steel disks, pressed against it by substantial springs which are tightened by nuts. The locking tube is connected by joints with the casing, which accounts for any relative motions between the axle and axle box (due to end play, wear, etc.).

This arrangement allows the sending apparatus to adapt itself to any motion of the axle without disturbing the tube, which, in its turn, is quite free with regard to any motion concerned.

The locking tube at the same time serves to receive a three-strand conductor cable, entering on one hand through a water-tight junction into the sender casing, and being connected on the other hand with a plug contact fixed to the free end of the tube.

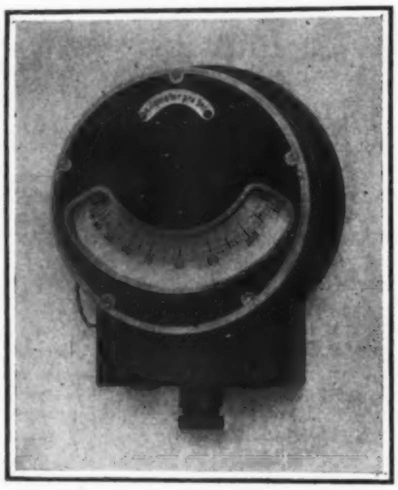


Fig. 2.—THE RECEIVING APPARATUS OF THE ELECTRICAL SPEED-GAGE.

The receiver (Fig. 2) is a three-phase volt-meter, consisting of an iron ring made up of thin sheets and carrying four pole pieces pointing radially inward. These pole pieces are fitted with coils of wire. In the middle of the iron ring there is a core of sheet iron which is sufficiently distant from the pole piece to allow an aluminium drum fitted above the core to rotate freely between the last and the pole pieces. The axis of this drum carries the index, which accordingly indicates any rotation of the drum. Two spiral springs wound in opposite directions are acting against the deflection of the index, tending to reduce it to its position of rest.

Each two opposite coils are arranged in series, and are connected to the conductors coming from the sending apparatus. The other terminals of the two pairs of coils are combined and connected through an adjustable resistance with the common return.

When, now, the two pairs of coils are traversed by the alternate currents of different phase generated in the sending apparatus, there is produced in the iron core a rotary field tending to deflect from their position of rest the aluminium drum, and accordingly the index of the instrument. This torque is counteracted by the two spiral springs, so that the index only is deflected from its position of rest through a given angle, corresponding to the actual tension of the current.

The index is adjusted instantaneously, any oscillations being damped efficiently by two substantial magnets acting on the aluminium drum and producing a Foucault current (due to magnetical induction) during its rotation. Whenever the number of turns of the locomotive action is altered, the tension generated in the sending apparatus, and accordingly the deflection of the receiver connected therewith, likewise undergo a variation, the scale of the receiver indicating immedately the traveling speed in kilometers per hour.

The receiver is arranged in an entirely inclosed water-tight iron housing mounted on a U-shaped iron strut screwed directly to the boiler, through the intermediary of a felt layer 10 millimeters (0.394 inch) in thickness.

The receiver is arranged in an entirely inclosed tion of rotation, corresponding to the forward course of the engine, any backward indications (in connection with which the whole scale can be utilized) being quite out of the question with most types of locomotives. Whenever the backward speed is also to be recorded, the receiver is readily designed for having the zero of its scale in the center, the index being deflected to the right in the case of forward, and to the left during backward traveling.

The sender and the receiver are connected by a three-strand armored rubber-lead cable, which, in order to be sufficiently protected in the case of any repair work on the side gears and cylinders, is laid out in an armored steel tube carried alongside the whole boiler at about 10 centimeters (3.94 inches) distance. To this tube is connected another tube carried alongside the smoke chamber wall to the front axle, in order to be connected there with the plug contact mounted on the locking tube of the sending apparatus.

The divisions of the receiver scale should be adapted to the traveling diameter of the axle driving the sending apparatus, as well as to the related speed limits.

A special advantage of this speed-gage, which is constructed by Messrs. Siemens & Halske of Berlin, is that the index and the receiver, both in the case of low and high speeds, remain absolutely quiet without performing any oscillation. Still, this index follows instantaneously any alteration in speed, be it ever so slight. The apparatus also indicates the actual speed at any moment.

The accompanying photographs represent the mounting of the receiver and the sender on an express locomotive of the Prussian-Hessian State Railways.

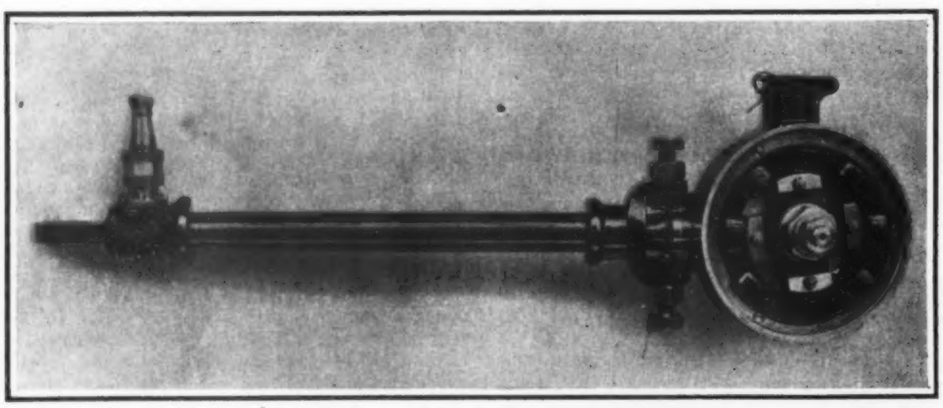


Fig. 1.—THE SENDING APPARATUS OF THE ELECTRICAL SPEED-GAGE.

SAVAGE RACES AND PHOTOGRAPHY.

In a lecture Dr. Rudolf Pöch gave an account of his experiences collected in the course of anthropological studies. He said: "It is well known that among Mohammedans there is, for religious reasons, a strong prejudice against photography, and, in general, against making any representation of the human form. Not so, however, among savages. As a rule the traveler will experience no difficulty whatever. The only danger is that they may misunderstand the whole operation, for instance, by mistaking the camera for a gun. Still, I recollect but one case in which a young man on the Island of New Mecklenburg, near New Guinea, took to his heels before my camera for this reason. It never happened elsewhere, since people had always been apprised of my friendly intentions before my arrival. I was traveling slowly and a good reputation preceded me. Still, possibly people might consider it burdensome to be photographed. For this reason it is best to consider the procedure as work performed and to pay for it accordingly. I would then often hear people say: 'We come to you willingly, to work for you means simply to sit down or tell you some story and you pay us as well as other white men for whom we have to work hard.' Even with such people, however, some opposition to being photographed may be developed by some accidental mistake. Some signs pointing that way have appeared. Thus, in New Guinea, I often heard photographing referred to as 'catching the soul.' If people have confidence in the photographer or if they consider him harmless, they will have no objection to his 'catching their souls.' If, however, they think him an evil sorcerer, they will certainly not allow it. A very curious reply was the one I received one day from a Kalahari bushman in a place where I had been staying for almost three months and where I had taken photographic, phonographic and cinemetographic records of a tribe. When I was about to leave, this man, seemingly very sad, said: 'Now you have taken our dances, our language and our portraits, and everything is being taken away to your country!'"
—Prometheus.

HYBRID BUTTERFLIES AND MOTHS.

A STUDY OF THEM IN CAPTIVITY.

BY KURT JOHN.

For several years many eminent biologists have been diligently making experiments in the hybridization of animal species. Hybrid forms are extremely interesting and instructive, because they afford a means of demonstrating the actual state of physiological divergence, i. e., the present stage of the constantly increasing isolation of separated groups of individuals, which are in process of developing into new species. The hybrid forms, furthermore, give an insight into the history of the parent species, as they often exhibit characters and properties which the parent species

Fig. 1.—Saturnia hybr. emiliæ (male). Produced by crossing Figs. 2 and 3.

formerly possessed, but have lost in the course of their development. When the parent species are nearly related, the prospect of obtaining a fertile cross is far greater than with two species which have become separated from each other, and fixed in their specific characters, at a very remote period. Most of such pairs of species, indeed, do not produce fertile crosses.

Forms of butterflies and moths are often found which present the general external appearance of known natural species, together with sufficient difference to make it plain that they do not strictly belong to the species in question. This occurs mostly in genera containing many species. Such a specimen may combine the characteristic markings of two species of the same genus, so that we are led to regard it as a

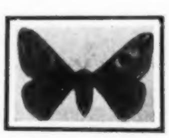


Fig. 3.—Saturnia pyri (female).

hybrid species. In hybridization, however, different influences are exerted by the two parents, so that the hybrid produced by crossing the male species A with the female species B, differs greatly from the progeny of the male of B and the female of A. The question, to which of these two crosses a specimen found in the wild state is to be attributed, can be decided with certainty only by experiments made with animals in captivity.

The hybridization of captive butterflies and moths constitutes one of the most difficult experimental researches of entomology, and requires an exact knowledge of the life and habits of the species employed. As the life of most butterflies and moths is very brief and as a large number of young and vigorous per-

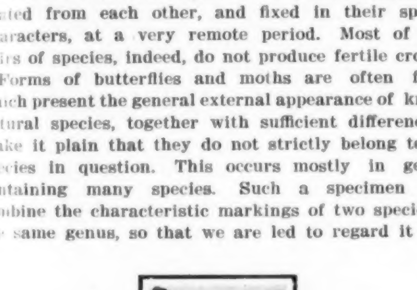


Fig. 2.—Saturnia pavonia (male).

fect insects are needed for such experiments (the crossing should be effected within two or three days after pupation), a very large number of living pupæ must be available. Even when the crossings are effected they are found to be infertile, in the majority of cases, and only a very small proportion of the eggs which are actually fertilized are capable of hatching and further development. It is usually very difficult, also, to rear hybrid larvæ, and even when they have attained full growth, they frequently fall victims to organic weakness or some of the diseases to which hybrid larvæ are especially susceptible.

I have already said that, in hybrid forms caught in the wild state, it is never possible to decide with certainty which parent species has furnished the male and which the female parent. Fig. 10 shows the result of a cross of the male of *Chærocampa Elpenor* (Fig. 11) and the female of *Metopsilus Porcellus* (Fig. 12), our medium and small grapevine moths. Such a specimen was caught by an electric light in Alsace in 1906, and was described accurately by Dr. Denso of Geneva. It was assumed that this specimen was the result of the cross mentioned above; but this was only an assumption. After unsuccessful experiments had been made by other biologists, I succeeded, in the summer of 1908, in producing this hybrid artificially in captivity, and thus in confirming the correctness of the assumption of the pedigree of the captured specimen. The new form has received the name *chærocampa hybr. luciani*. It is worthy of mention that

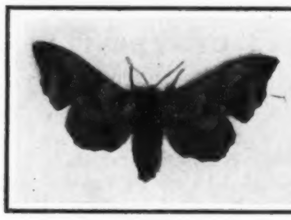


Fig. 4.—Smerinthes hybr. hybridus (male). Produced by crossing Figs. 5 and 6.

Fig. 5.—Smerinthes ocellata (male).

Fig. 6.—Smerinthes populi (female).

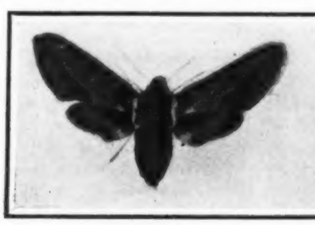


Fig. 7.—Deilephila hybr. Densoi (female). Produced by crossing Figs. 8 and 9.

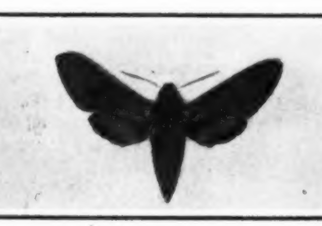


Fig. 8.—Deilephila vespertili (male).

Fig. 9.—Deilephila euphorbo (female).

Fig. 10.—Chærocampa hybr. luciani (male). Produced by crossing Figs. 11 and 12.

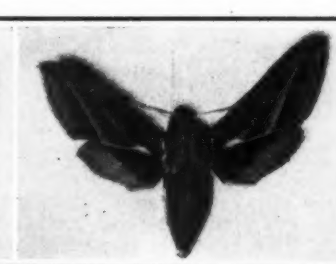


Fig. 11.—Chærocampa elpenor (male).

Fig 12.—Metopsilus porcellus (female).

the male and female hybrids differ greatly in coloring, although in each of the parent species the markings of the two sexes are alike.

Another very interesting hybrid is that of the male of *Saturnia pavonia* (Fig. 2) and the female of *Saturnia pyri* (Fig. 3). *Saturnia pavonia*, the small peacock moth, is found throughout Central Europe, while *Saturnia pyri*, the large or Vienna peacock moth, is found only in the south, especially in Dalmatia. The hybrid (*S. hybr. emiliæ*, Fig. 1) was first produced more than twenty years ago by the eminent Swiss naturalist, Prof. Standfuss, and it then attracted much attention from entomologists. This beautiful creature has subsequently been produced by hybridization by several experimenters. The specimen here illustrated, like all of the other hybrids shown with the exception of *Deilephila hybr. Densoi*. (Fig. 7), is the result of my own experiments.

Another very pretty hybrid form is *Smerinthus hybr. hybridus* (Fig. 4), obtained by crossing the male of the well-known willow moth (*S. ocellata*, Fig. 5) with the female of the poplar moth (*S. populi*, Fig. 6). This cross is very easy to effect, especially for the reason that it is not difficult to obtain living pupæ of both of these common species in great numbers. Of nine crossings which I succeeded in obtaining in June, 1907, two proved fertile. The hybrid moths emerged from their cocoons in August and September of the same year, although the parent species usually pass the winter in the pupal state, and the moths do not emerge until the following May or June. These hybrids moths proved to be almost exclusively males, only about 2 per cent being females. The latter were imperfectly developed sexually and were really gynandromorphous or hermaphrodite forms.

This preponderance of males is very often observed in hybrids. Many crosses produce males exclusively, the females dying in the embryo state, i. e., in the egg.

A rare specimen is the product of the opposite cross of these two species, i. e., of the male of *S. populi* and the female of *S. ocellata*. In this case the character of the offspring is so strongly influenced by the male parent (whose species is very old with very firmly fixed characters and physiological type) that the large blue spot upon the posterior wing which is characteristic of *S. ocellata* and which in this case, therefore, must be inherited from the female parent, if at all, is lacking as completely as it is in *S. hybr. hybridus* (Fig. 4). Hybrids are usually influenced more strongly by the male than by the female parent, and if the male parent belongs to an older species than the female, the approximation of the hybrid to the male parent is still greater. The hybrid of the male *S. populi* and the female *S. ocellata*, indeed, resembles *S. populi* so closely that it cannot be distinguished from it. The rarity of this hybrid is due to the fact that in this cross the combination of the germinal cells is so unfavorable that the embryo possesses little vitality and always dies in an early stage of development.

Hence I rejoiced greatly when, in June, 1907, I obtained from this cross a cluster of one hundred eggs which proved fertile without exception. The young larvæ were developed, which, within ten or twelve days, however, were unable to penetrate the shells of the eggs. This peculiarity is often observed in hybrid larvæ, and it must be attributed to organic weakness. The few specimens which have hitherto resulted from this cross have been neither male nor female, but intermediate forms similar to the *gynandromorphous* females of *Smerinthes hybr. hybridus*.

Deilephila hybr. Densoi (Fig. 7) is the result of crossing the male of the South European bat moth (*D. vespertilio*, Fig. 8), with the female of the spurge moth (*D. euphorbiæ*, Fig. 9), which is very common throughout Europe. The hybrid very closely resembles the species of the female parent. Hence it may be assumed that this species is of far older development that *S. vespertilio*, a supposition which is confirmed by its wide range of habitat and of variation. In general *S. euphoriæ* appears to be a species which is on the point of separating into new local species.

That there are also cases in which fertile crosses may occur between species which are not very nearly related, is proved by the result of an experiment in crossing the male of *Saturnia pavonia* (Fig. 2) and the female of *Graellsia Isabellæ*, a green and tailed Spanish species, which is very dissimilar from the type of *Saturnia*. From 130 eggs which were produced 16 larvæ emerged. I succeeded in rearing these to the third change of skin, and then they all died. A similar negative result had previously been obtained by Standfuss. The production of perfect insects from this cross would be of great scientific interest.

As hybrid forms are often found in the wild state, it might be assumed that, in the course of time, new species would be developed by the repetition of such natural crosses. This, however, is impossible for the following reasons: The females of primary hybrids, or hybrids of the first order, resulting from the crossing of two pure natural species, prove, so far as they have been examined, to contain no ova capable of development. Hence such females are incapable of producing offspring. The male hybrids resulting from some of these crosses are fertile, though less so than the parent species. They usually pair with the females of either parent species. Now the crossing of the male hybrid with the female of the older of the two parent species produces a larger percentage of viable eggs than is obtained by crossing the same male hybrid with the female of the younger species. The progeny of either of these crosses is called a secondary hybrid, or a hybrid of the second order. It approximates most closely to the maternal type, and when crossed repeatedly with the maternal species it is gradually absorbed by it.

By the crossing of a male primary hybrid with the female of a natural species, nature appears to indicate a method of producing, in comparatively large numbers, the rare gynandromorphous forms which show the characters of both sexes. At least, this result has often been obtained in crosses of species of *Saturnia*. No success has yet been obtained from attempts to produce externally hermaphrodite butterflies and moths by transplanting the genital organs of larvæ.

The experimental researches described above belong to the most instructive of entomological studies. The whole development of these small and delicate creatures, which usually accomplish their complete metamorphoses within a few weeks, offers so much that it is interesting, and even astonishing, that the lover of nature cannot be too earnestly urged to devote attention to these insects. To any one who with love and diligence seeks to penetrate into the secrets of life of these small creatures a new and vast field of discovery will be opened. In particular, the study of the biological development of hybrids is quite indispensable to the naturalist, as it gives an insight into the history of the development of species, and indicates their proper places in the biological system of classification.—Translated for the Scientific American Supplement from Illustrate Zeitung.

JOHN DALTON AND HIS ACHIEVEMENT.*

A GLIMPSE ACROSS A CENTURY.

BY PROF. R. M. WENLEY, UNIVERSITY OF MICHIGAN.

Honored by my scientific colleagues, in associating with me in an effort to pay worthy homage to the genius of John Dalton (1766-1844), whose "A New System of Chemical Philosophy," had reached all its epoch-making significance, I introduce the subject with some account of the difficulties, amazing to us in our conditions, under which this strenuous pioneer labored. To this end, we must try to pierce the cultural inwardness of English life at the close of the eighteenth century, keeping in mind the peculiar qualities that characterize English science even yet.

I.

The bare facts of Dalton's story need interpretation. Born in a little village of Cumberland of a Quaker family, Dalton's social relations isolated him from the chief cultural organs of the national life. Till the tender age of twelve he received such instruction as the local Friends' school afforded, and he appears to have made excellent use of his opportunities: then he went to work as a teacher there for three years.

At fifteen he migrated to Kendal, where he taught in a mixed school. Here he spent twelve years, fruitful in many respects. For, the day's darg done, he contrived to improve himself by private study of Latin, Greek, French, mathematics, and "natural philosophy."

In 1793 he removed to Manchester, at which place he had been appointed science tutor in New College, and therefore once more without the pale of national higher education; he held this position for six years, at a salary of $400. On the transference of the college to York, he resigned, and gave himself to private tuition, a vocation sufficient for daily bread. But the Manchester experience proved a turning point, for it offered an environment wherein he could make pure science his avocation. From 1786 Dalton had been engaged in meteorological observations, and published his maiden work in the autumn of 1793—"Meteorological Observations and Essays." Thanks to his connection with the Manchester Literary and Philosophical Society, he read his famous paper, "Extraordinary Facts Relating to the Vision of Colors," in October, 1794. In 1801 he presented his first classical research, "On the Constitution of Mixed Gases," which was followed by three memorable papers, "On the Force of Steam or Vapor from Water and other Liquids in Different Temperatures, both in a Toricellian Vacuum and in Air," "On Evaporation" and "On the Expansion of Gases by Heat." In the last he enunciated the law of expansion of gases formulated by Gay-Lussac a few months later.

It was in 1802, after six years of research in chemistry, that he referred to the possibility of multiple proportionate combinations of the elements, in a paper entitled "On the Proportion of the Several Gases or Elastic Fluids Constituting the Atmosphere." The atomic symbols devised by him are first found in his note-book of 1803; and a table of atomic weights, showing that, by this time, he had grappled with the fundamental problem—that of fixed "relative weights of the ultimate particles of bodies." Dalton appended it, in a somewhat different form, to a paper "On the Absorption of Gases by Water." The first part of the first volume of the "New System of Chemical Philosophy," published in 1808, gives the mature theory, while the second part of 1810 describes the chemical elements in detail. Dalton was now forty-four, and it is significant that, although he had lectured twice at the London Royal Institution, and in Glasgow and Edinburgh as well, the French Academy of Science recognized his merits six years before any native body. In 1822, Dalton being fifty-six, the Royal Society honored itself by his election. Oxford conferred her D. C. L. on the occasion of the second meeting of the British Association, 1832, and he was sixty-eight when Edinburgh enrolled him among her honorary doctors. In 1833 he received a civil list pension, increased afterward in 1836, when the announcement was publicly made by Sedgwick, at the Cambridge meeting of the British Association, who remarked in his striking speech, "without any powerful apparatus for making philosophical experiments—with an apparatus, indeed, many of them might think almost contemptible—and with very limited external means for employing his great natural powers, he had gone straight forward in his distinguished course, and obtained for himself, in those branches of knowledge which he had cultivated, a name not perhaps equaled by that of any other living philosopher of the world."

II.

Dalton maintained silence from 1793 till 1799, hindered, perhaps, by college duties. On reappearance, he soon dropped the rôle of meteorologist for that of chemist and physicist. The new line was taken in the paper entitled "Experiments and Observations on the Power of Fluids to Conduct Heat, with Reference to Count Rumford's Seventh Essay on the same Subject," read before the Manchester Society on April 12, 1799. The simple nature of his apparatus may be illustrated aptly from this communication:

"Took an ale glass of a conical figure, 2½ inches in diameter and 3 inches deep; filled it with water that had been standing in the room, and consequently of the temperature of the air nearby. Put the bulb of a thermometer in the bottom of a glass, the scale being out of the water; then having marked the temperature, I put the red-hot tip of a poker half an inch deep in the water, holding it there steadily for half a minute; and as soon as it was withdrawn, I dipped the bulb of a sensitive thermometer about ¼ inch, when it rose in a few seconds to 180 deg."

Then follow the tabulated temperature results. Another experiment, described in the same paper, suffices to show that Dalton had pondered the discontinuity of matter thus early. Having mixed hot and cold water for half a minute, he proceeded to determine whether the upper layer became warmer than the lower. Observing that it did not, he remarked: "If the particles of water during the agitation had not actually communicated their heat, the hot ones ought to have risen to the top, and the cold ones subsided, so as to have made a material difference in the temperature." Furthermore, these and many other experiments afford us indications of his mental habit as a scientific investigator. Conceptual processes find him at his best; his theoretical expectations and deductions are good. In experiment he is not so happy, and what we understand by "fine" or refined work occurs seldom. Thus, in the case just cited, Dalton infers "that the expansion of water is the same both above and below the point of maximum density." But, when he comes to determine this crucial point precisely, he goes wide of the mark, setting it at 36 deg.

These references may enable us to grasp his manner of approach to a problem, and to realize his general plan of attack upon the atomic constitution of matter as it stood when he entered the field.

Scientific men themselves misconceive the doctrine of "matter" at times, not deliberately indeed, but because, absorbed in researches of immediate moment, they have not troubled to follow the marvelous story with patience. The long, tortuous endeavors that culminated in Dalton's atomic theory, with its kernel, the law of multiple ratios, are the tale of man's attempt to reduce his notion of "matter" to conceptual simplicity; this to the end that it might be rendered an obedient instrument. Freed from contingent accessories, the central problem was this: Given such a vast multiplicity and variety of phenomena as the "substantial" world presents, how can all be grasped under a single, synthetic idea? Plainly, whenever man began to reflect upon nature, he encountered this sphinx. The elusive, yet persistent, relationship between the one and the many, forms part of ancient history in science no less than in metaphysics.

Omitting the metaphysical reference in favor of the natural-scientific, it may be affirmed that the problem itself is also a many in a one.

In the first place, a particular phenomenon must be selected, and treated as the starting point. This done, it is requisite to obtain an all-round view of what it is. In the second place, one must proceed to elucidate its relations to other phenomena, preferably to those which evince evident, or apparent, kinship. In the third place, order must be induced in the relations that have thus come under observation, by reducing them, as far as possible, to numerical expression. The primary methods of weighing, measuring and enumeration must be invoked. This achieved, we may assert that we have arrived at that species of conceptual simplicity which we call a "law of nature." On a broad view, it is fair to say that, prior to Dalton, investigation and fancy pursued the one (i. e., the conception of "matter") through the many (i. e., these three aspects of the problem). For, on the whole, till we come to J. J. Becher (1635-82) and G. E Stahl (1660-1734), the element theory held the field. And this is only to affirm that men were trying to master the properties of particular bodies, while reserving the remoter question of the ultimate constitution of "matter."

The age of phlogiston, with its theories of combustion, marks a move to the second question. Men are now engaged in an effort to relate phenomena. In a word the most different phenomena, such as the burning of carbon and the calcination of a metal, are shown to belong to the same class, and to be explicable by a simple conceptual hypothesis. Finally, when Lavoisier sent phlogiston by the board, the

* Read before the Research Club of the University of Michigan at its annual memorial meeting. Reprinted (condensed) from the Popular Science Monthly.

third question came to the fore, and men began to ask, How can we weigh, measure and enumerate the exact degree of relationship between the properties of substances? Dalton ranks among the great epoch-makers, because he first brought this inquiry within the range of practicable *uniformity*.

I am well aware that scientific chemistry is dated usually from 1776, when Lavoisier made the balance the chemical instrument; but you will bear with me if I travel a little farther back and find the initial point in the classical investigation of latent heat, conducted by Black between 1759 and 1763, at Glasgow. Nevertheless, as Dalton's priority has been impugned, we are bound to consider the facts.

Every one knows that the conception of the discontinuity of "matter" appears in ancient history. In modern times, Boyle (1627-91) speaks of corpuscles, Boerhaave (1668-1738), of *massulæ*. Moreover, Dalton was a youth of only seventeen when the most important developments occurred. First, and with special reference to the framework of possible method, we have Lavoisier's (1743-94) celebrated memoir "Reflections concerning Phlogiston," in which he establishes the *quantitative* method on a firm basis. In 1783, Bergman (1735-84), the last of the great phlogistic chemists, published his notable work on what he called "elective attraction" (i. e., affinity). Naturally, Bergman's table of "single elective attractions in the moist way, and in the dry way," was a description of *qualitative* relations. It marked the beginning of investigation of mass action, and provoked the striking researches of Berthollet (1748-1822), who, in 1799, presented his paper, "Recherches sur les lois de l'affinité," out of which grew his major work, "Essai de statique chimique" (1803). The main result of his assault upon Bergman was to show that chemical change depends, not merely upon the affinities of the substances involved, but upon their *quantities*. In other words, a new method asserted itself. For, as Berthollet says:

"To find the affinity of two substances toward a third, in accordance with the conception we have now gained of affinity, can mean nothing other than to determine the *ratio* in which this third substance divides itself between the first two."

Therefore, chemical change hinges upon the nature of the relative *masses* of the substances involved, but, "to determine the ratio of the affinities of two substances toward a third . . . is attended by unsurmountable obstacles." Baffled in every attempt to determine the distribution of salts in solution, Berthollet had good reason to doubt the doctrine of constant composition. Proust (1755-1826) was able to enunciate the law of fixed proportions, "affinity and fixity of composition, the two poles about which revolves immutably the whole system of true compounds, whether produced by Nature or by Man;" or, as Lothar Meyer phrases it, "Definite chemical compounds always contain their constituents in *fixed* and *invariable* proportions." Notice, in the words I have italicized, the unanimous trend toward *quantitative* measurements and accuracy, the ruling notion being that of *numerical ratio*.*

We come to closer quarters with our central theme in Richter (1762-1807). Richter arrived at the law of equivalent ratios—"The qualities of acids and bases equivalent in one neutralization are equivalent in all." In 1802 Fischer made Richter's conclusions known to Berthollet, and chemical ratios became an integral part of the science.

He discovered the law of permanent proportions, and the experimental proof was clinched by Berzelius in 1811-12, and the law of "permanent" or "definite" ratios, as it is called now, put the problem of composition on a practicable footing. It should be noted also that, in stating the numerical values of the elements, Dalton employed some determinations of other chemists, at all events as checks.

We are now in a position to see that series of complicated researches, all looking to *quantitative* results, furnished Dalton with material which enabled him to render the atomic theory perspicuous and applicable from the very outset. Notwithstanding, to him must be given sole credit for the final simplification, which had been exercising his mind for some eighteen years —since 1790, in fact. A quotation from Berthollet's "Essai" (1803) may suffice to emphasize the long step due to Dalton's insight.

"Some chemists, influenced by having found determinate proportions in several combinations, have frequently considered it as a general law that combinations should be formed in invariable proportions; so that, according to them, when a neutral salt acquires an excess of acid or alkali, the homogeneous substance resulting from it is a solution of the neutral salt in a portion of the free acid or alkali. This is a hypothesis which has no foundation, but a distinction between solution and combination."

Undoubtedly, events tended toward the new climate of opinion, nay, this had become so far prevalent that William Higgins (17?-1825) came nigh playing Wallace to Dalton's Darwin. Indeed, in 1814, he raised a claim to priority, which was disproved at once by Thomson, the Glasgow chemist, who had made Dalton known.

Higgins, the claimant of 1814, published his book in 1789. It contains forecasts of the atomic theory, such as the following:

"I am likewise of opinion that every primary particle of phlogisticated air is united to two of dephlogisticated air, and that these molecules are surrounded with one common atmosphere of fire."

III.

Finally, coming to Dalton's characteristics as a thinker, we may find the clue in his forcible independence. In the preface to Part II. of "A New System of Chemical Philosophy," he declares:

"Having been in my progress so often misled, by taking for granted the results of others, I have determined to write as little as possible, but what I can attest by my own experience. On this account, the following work will be found to contain more original facts and experiments, than any other of its size, on the elementary principles of chemistry."

Here the strong man places himself on record, and the question of priority takes to flight. Accordingly, I state it as my clear impression that the merits and defects of his achievement are alike traceable to the fact that our laureate lay under direct obligation to but one of his predecessors—Newton. Dalton encountered certain phenomena, such as multiple and definite proportion, aqueous vapor as a distinct constituent of air, and, seeking for the simplest common representation, found it in Newton's well-known doctrine. For example, he says:

"According to this view of the subject (heat), every atom has an atmosphere of heat around it, in the same manner as the earth or any other planet has its atmosphere of air surrounding it, which can not certainly be said to be held by chemical affinity, but by a species of attraction of a very different kind."

And he quotes from Newton:

"All bodies seem to be composed of hard particles. . . . Even the rays of light seem to be *hard* bodies, and how such very hard particles which are only laid together and touch only in a few points, can stick together, and that so firmly as they do, without the assistance of something which causes them to be attracted or pressed toward one another, is very difficult to conceive."

This was the secret of the opposition of Hope and, later, of Faraday's complaint. In a letter, dated January 2, 1811, Hope wrote to Dalton as follows:

"I need not conceal from you that I am by no means a convert to your doctrine, and do not approve of putting the result of speculative reasoning as experiment."

While Faraday, similarly suspicious, as late as 1844, said:

"The word atom, which can never be used without involving much that is purely hypothetical, is often *intended* to be used to express a simple fact. . . . There can be no doubt that the words definite proportions, equivalents, primes, etc., . . . did not express the hypothesis as well as the fact."

The truth is that Dalton was a first-rate theorist, who arrived at his conclusions, not primarily on the basis of induction from experiment, but by reflection. Analogically, he imports the view of "matter" peculiar to celestial mechanics, through molecular physics, into the realm of chemistry. Proceeding thus deductively, he evinces little awareness of the very complex problems involved, which the later developments of the atomic theory were to reveal. Cut off from the world, he did not possess intimate acquaintance in detail with the labors of his immediate predecessors and contemporaries—a happy accident, no doubt. For, this freedom from puzzle and disturbance enabled him to proceed boldly with a generalization when men of the caliber of Wollaston and Davy hung back. Dalton had natural capacity for logical thought, and complete confidence in the validity of those mathematical syntheses of *physical* facts which he had pondered.

But, as happens frequently, his limitations are traceable to the same source. Like Kant before him, Dalton became so entangled in the theoretical ways of his own thought that, after he had promulgated his theory, he stopped short in middle life, and could not appreciate the work of others who followed and supported him. This is the blot on his 'scutcheon. Still, even so, we must hold the balance true. The kinetic doctrine of "matter," integral to the Cartesian philosophy, had paled before Newtonian atomism. And Dalton had grasped Newton's view so logically that he could not admit the law of equal volumes, because, as he held, "no two elastic bodies agree in the size of their particles." The very success of his hypothesis blinded him to Gay-Lussac's experimental evidence—it would not conform to the conceptual scheme. As he wrote to Berzelius, in September, 1812:

"The French doctrine of *equal measures* of gases combining, etc., is what I do not admit, *understanding it in a mathematical sense*. At the same time I acknowledge there is something wonderful in the frequency of the approximation."†

Of course, the fact was that, as Wurz points out,

"The relation which exists between the densities of gases and their atomic weights is not so simple as we should at first sight be led to expect, and as for a long time it was thought to be."

Nay, "understanding it in a mathematical sense," Dalton had his reasons. By a kind of paradox, the very simplicity of his notion befogged him here, just as the problems bred of the atomic theory diverted chemists for many a long day from the study of affinity.

We may conclude, then, that the logical character of Dalton's mind enabled him to formulate the timely conceptual representation on which chemical logic has pivoted ever since; that his numerical conception has stood the test of further discovery better than most hypotheses; and that, little as he knew it, or could admit it at the moment, he laid the foundation for that intimate alliance between physics and chemistry which forms one of the most pregnant among contemporary movements. For, the active criticism of the atomic theory—that it dogmatizes about the physical constants marking the differences between the elements, that it reveals little or nothing of the *processes* incident to chemical composition and destruction, that it neglects synthesis—testifies also, if negatively, to the revolution wrought by its author. Pity is akin to praise here. And to-night, as we celebrate Dalton's "thoughts that breathe," we are bound to let praise have its free way, especially when we contemplate the indomitable devotion of a character who, amid sore difficulties, but furnished with the splendid spur of consecration to the ideal, achieved so much for man's conquest of the secrets of nature.

* The italics are mine.

† The italics, "understanding," etc., are mine.

ASTRONOMICAL METHODS AND INSTRUMENTS.

In experiments made last year on the resolving powers of large and small telescopes, Burnham found it impossible to resolve, with a 36-inch telescope double stars whose components are separated by less than 0.13 second, although a 6-inch glass resolved doubles with an interval of 0.30 seconds. The resolving power, therefore, is not proportional to the aperture. Innes attributes the relative inferiority of large telescopes to the fact that they require atmospheric conditions which are seldom realized.

Double objectives are still generally employed in astronomy, although triple objectives are theoretically better and have been used with success in terrestrial photography. Gifford has constructed a perfectly achromated triple objective, employing a special method and very fine spectral lines for the determination of the refractive indices with the requisite precision.

Lowell has installed a 40-inch reflector at Flagstaff for the photographic study of planets and nebulæ. The mirror of St. Gobain glass, made by the Clark firm, has a mounting of iron and zinc, so combined as to make the mean expansion equal to that of glass. The new 60-inch Ritchey reflector at Mt. Wilson has yielded such excellent results that a 100-inch mirror has been ordered.

An observatory devoted to meridian measurements of fundamental stars is being constructed at San Luis, Argentina, by the Carnegie Institution.

Sir William Huggins presented to the Cambridge Observatory the instruments used in his classical astrophysical researches.

Davidson and Melotte of Greenwich have devised an electrically heated plateholder to protect plates from injury by moisture in long exposures.

The Astrographic Conference, which met in Paris in April, 1909, adopted measures designed to expedite the completion of the international map of the heavens and appointed a commission to determine the meridian positions of stars of reference. Simon Newcomb was placed at the head of the commission by a unanimous vote, but that illustrious American did not live to render this additional service to astronomy. His death, which occurred on July 11, 1909, removed one of the great men of science of the nineteenth century.

To Attach Labels, Mould Proofs.—Add 2 parts of borax to 1,000 parts of paste. To prevent peeling off: add a small quantity of fluid glue (ordinary joiners' glue, steeped 12 hours in water, melted and diluted with vinegar added), 1,000 parts of liquid glue to 2,000 parts of paste.

SCIENCE NOTES.

A French patent has been taken out by P. Friedrich on the manufacture of artificial threads. By using cuprammonium cellulose solutions of great tenacity, as, for example, those containing, in addition to cellulose, such substances as carbohydrates of alcohols, and addition thereto filaments squirted in the usual manner may be drawn out into very fine threads and hardened in a single coagulating bath. The cellulose solution should contain a smaller quantity of ammonia than of cellulose, and it should have such a tenacity that it can be drawn into filaments 50 centimeters long in the air; the concentration of the coagulating bath should be so adjusted that the filament can be drawn out without breaking during the first 10 centimeters of its passage through the bath.

Mr. F. K. Cameron ventures the opinion that the study of the soil solution is of the first importance in the investigation of the relation of the soil to plant growth, and in the Journal of Physical Chemistry he gives an outline of the present knowledge of the chemical principles involved, together with a discussion of the essential physical and biological factors. The subject is treated under the following headings: Soil management or control; soil analysis and the historical methods of soil investigation; the plant-food theory of fertilizers; the dynamic nature of soil phenomena; the film water; the mineral constituents of the soil solution; absorption by soils; the relation of plant growth to concentration; the balance between supply and removal of mineral plant nutrients; the organic constituents of the soil solution; fertilizers; alkali.

There are at least four factors involved in the solution of the problem of maintaining prosperity, civilization and universal education in this country. These four factors may be classified as exploitational, scientific, legal, economic. 1. Further exploitation of our remaining virgin soils, as by irrigation and drainage, neither of which is of large significance in comparison with the magnitude of our present agricultural development. 2. The restoration, by practical scientific methods, of depleted lands and large increase in productive power of practically all lands now under cultivation. This is the only great positive factor. 3. The legal control of increase in population by the enactment and enforcement of suitable laws. 4. The reduction in the standard of living, by extending the tendency already enforced to some extent, as in the gradual withdrawal of meat and other valuable food products from the daily diet, and adopting such standards as are common in China and Japan, where beef, butter and milk are practically unknown.

Some say that the economic conditions have been such that the depletion of the lands of the eastern states has been a necessary sequence, and that the restoration of those lands will now follow as an economic necessity. If systems of permanent progressive agriculture are ever to be adopted anywhere in this country, it must be done while the landowners are still prosperous. Some investment is necessary for the restoration of depleted soil, and poverty makes no investments. Much of the abandoned lands of America are far past the point of possible self-redemption. They were depleted not because of any economic necessity, but because of ignorance, and the fault lies not with the farmers and land owners, but with the educators who even until the present generation have taught almost everything except the application of science to agriculture. The fault lies also with the statesmen who, as James J. Hill says, have "unduly assisted manufacture, commerce, and other activities that center in cities, at the expense of the farm."

A paper dealing with the thermal conductivity of substances artificially rendered anisotropic, is published by A. Badior. The methods of research were similar to those of Sénarmont and Lees. Sénarmont's method was as follows: A plate of the substance had a hole drilled through the center through which passed an electrically heated Pt-wire. The plate was smeared with wax and turpentine and pressure applied to two sides of it by means of a parellel vise. The isothermals showed by the melted wax were ellipses, whose minor axes were parallel to the direction of the applied pressure. The experiments made by Mr. Badior lead to the following conclusions: For glass and slate subject to one-sided pressure no difference of the conductivities parallel and perpendicular to the direction of pressure can, within the limits of accuracy of the experiments (about 1 per cent) be detected. The results of Sénarmont, showing better conductivity perpendicular to the direction of pressure than parallel thereto, are traced to the disturbing influence of the clamps on the diffusion of heat and on the form of the isothermals. For stretched India rubber no difference of conductivity in the two directions can be detected. With naturally stratified substances such as schists and some sand stones there is slightly better conductivity in the direction of the lamination than perpendicular thereto. In a laminated body consisting of alternate layers of equal thickness but of different conducting powers, heat travels better along the layers than perpendicular to them. The isothermals in a plane perpendicular to the layers are ellipses with their major axes parallel to the layers. From the ratio of the axes the ratio of the conductivities of the different materials can be calculated. The latter results give a probable explanation of the difference of conductivity in two directions with naturally stratified substances.

ENGINEERING NOTES.

In Hahl and Eisen, A. Knaff describes the use of blast furnace slag for paving stone and for concrete. Paving stone prepared from the inner portions of the mass of slag, which must be quite cool before being broken, was found to have a crushing strength of 761 kilograms per square centimeter. Large quantities of concrete made from blasting furnace slag have been used in the erection of iron works at Wissen. The foundations for heavy machines, boilers, and chimney-shafts were made of concrete containing large lumps of slag. Test pieces of a concrete consisting of 150 parts of slag, 100 parts of slag-sand, and 25 parts of cement, had a crushing strength of 120 kilograms per square centimeter, and with 32 parts of cement, 160 kilograms per square centimeter. Pieces broken off from the foundation after several years had a crushing strength of 35 to 55 kilograms per square centimeter. The difference is considered to be largely due to the more careful preparation of the concrete for the original test-pieces.

Experiments were made during the summer of 1909 at Washington, D. C., Youngstown, Ohio, and Ithaca, N. Y., with different preparations for the prevention of dust and the preservation of roads. At Washington, waste sulphite liquor was used on a macadam driveway subjected to light traffic. Sulphite liquor is a dense sticky liquid produced in the manufacture of wood pulp. It was applied in mixtures with water in varying proportions. The results show that it has but little value as a permanent road treatment, but that in concentrated form it may be classed as a temporary or semi-permanent dust preventive and road binder. At Youngstown, blast furnace slag was used alone and in different combinations with lime, sulphite liquor, and tar to determine the best method of utilizing slag for road construction. While sufficient time has not elapsed since these experiments were made to show definite and permanent results, it is believed that they will be valuable in determining what combinations will produce the best road. At Ithaca, tar, oil, artificial asphalt preparations, brick, cement, and slag were used with varying results. All of these experiments are fully described, with results produced in each case, and a report on experiments formerly made, in Circular 93 of the Office of Public Roads, U. S. Department of Agriculture.

TRADE NOTES AND FORMULÆ.

Anhydrous Varnish (coating for damp walls and wood).—200 parts of black pitch, 50 parts pine resin, 20 parts colcothar, 50 parts washed chalk, melted together; apply hot.

To Clarify Cloudy Vinegar.—Add skimmed milk in the proportion of 1 part to 100 in white and 2 to 100 parts in red colored vinegar. The mixture must be thoroughly stirred and set aside to settle.

To Bleach Ivory.—Treat the ivory alternately with a solution of permanganate of potash (5 to 1,000) and a solution of oxalic acid (10 to 1,000). Allow it to lie in each solution for half an hour, then rinse it well with water; repeat the process several times.

Cement for Quickly Closing Leaky Spots in Casks.—1. Tallow 25 parts, wax 20 parts, lard 40 parts, sifted wood ashes 25 parts. 2. The leaky spot in the cask is dried as far as possible and painted with a brush with concentrated water glass. Then the spot is dusted with dry cement powder, more cement powder is poured on to it and forced into the aperture. 3. Very badly leaking places are coated with cement, mixed with water glass, to form a thick paste.

Window Panes Indicating Moisture in the Air.—Paint them with the following solutions: 1. chloride of cobalt 1 part, gelatine 10 parts, water 100 parts; 2. chloride of copper 1 part, gelatine 10 parts, water 100 parts; 3. chloride of cobalt 1 part, gelatine 20 parts, water 200 parts, nickel oxide 0.75 parts, chloride of copper 0.25 parts. In cloudy weather the surfaces are colorless, in bright weather if coated with No. 1 they are blue, with No. 2 yellow, with No. 3 green.

Fireproof Substance that is Hard and Shiny.—To a solution of 200 parts of caseine, in 50 parts of spirits of sal ammoniac and 400 parts of water, add 240 parts of caustic lime, 150 parts of acetate of alumina, 50 parts of alum, 1,200 parts of sulphate of lime and 100 parts of oil. The mass must be thoroughly kneaded and passed between rollers. The sheets thus obtained are dried and pressed in hot metallic molds, or pulverized, loaded into molds and subjected to heavy pressure. The molded objects are placed in a bath of 100 parts water and 10 parts phosphoric acid, then dried, polished and varnished with shellac.

Colored Pencils for Writing on Glass, Porcelain and Metal.—1. Black: lampblack 10 parts, wax 40 parts, tallow 10 parts. 2. White: Krems white 40 parts, wax 20 parts, tallow 10 parts. 3. Pale blue: Berlin blue 10 parts, wax 20 parts, tallow 10 parts. 4. Dark blue: Berlin blue 15 parts, gum 5 parts, tallow 10 parts. 5. Red: cinnabar 20 parts, wax 60 parts, tallow 20 parts. 6. Yellow: chrome yellow 10 parts, wax 20 parts, tallow 10 parts. The colors are incorporated with the fatty substance in a warm state, finely rubbed down and dried in the air to such an extent that by means of an hydraulic press they can be pressed like lead pencils into round sticks. They are then further air-dried and when of the proper consistency are glued into the wood.

Iron Alloys for Casting Boring and Cutting Tools (F. W. Martino).—1. For casting boring tools: Crude iron, 17.25 parts; manganese iron, 4.50 parts; chromium, 2 parts; metallic tungsten, 7.50 parts; aluminium, 2 parts; nickel, 0.75 parts; copper, 1 part; bar iron, 5 parts. 2. Crude iron, 17.25 parts; manganese iron, 3 parts; chromium, 1.50 parts; metallic tungsten, 5.25 parts; aluminium, 1.25 parts; nickel, 0.50 parts; copper, 0.75 parts; bar iron, 70.50 parts. First melt the crude iron, manganese iron, chromium and tungsten in graphite crucibles, with a covering of wood charcoal and calcined borax, the alloy with the bar iron to be again brought to the melting point in clay crucibles, and the nickel, copper and aluminium, added. The alloy may then be covered in the clay crucibles with wood charcoal with which a little flux may be mixed.

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